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# JOURNAL

OF THE

# ROYAL MICROSCOPICAL SOCIETY;

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS,

AND A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY

(principally Invertebrata and Cryptogamia),

MICROSCOPY, &c.

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*Edited by*

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*One of the Secretaries of the Society*
*and a Vice-President and Treasurer of the Linnean Society of London;*

WITH THE ASSISTANCE OF THE PUBLICATION COMMITTEE AND

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Fig. 1.

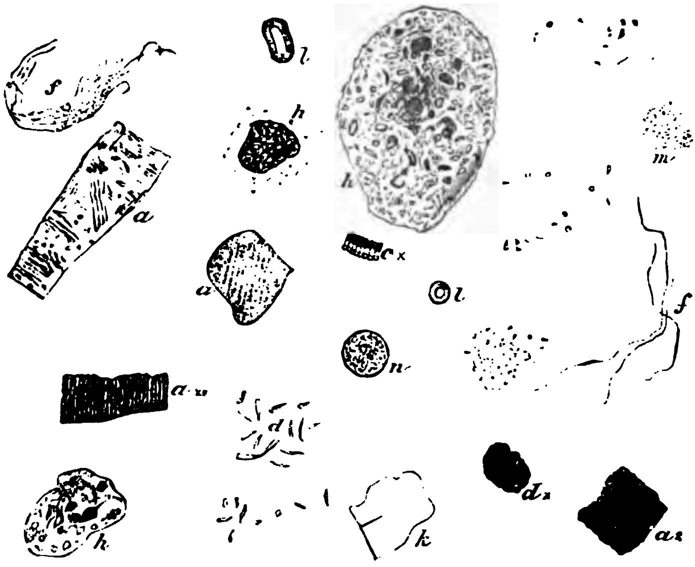


Fig. 2.

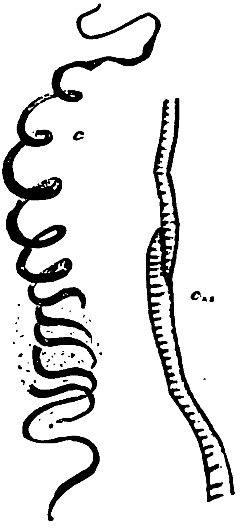
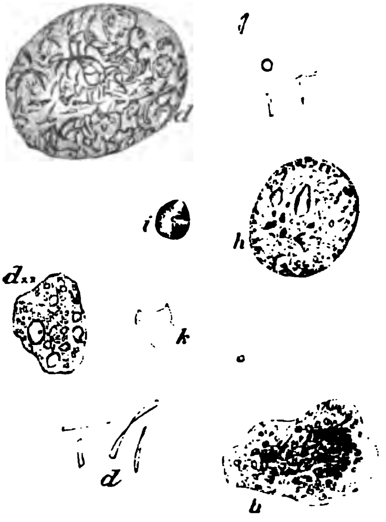


Fig. 3.



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## TRANSACTIONS OF THE SOCIETY.

### I.—*The Constituents of Sewage in the Mud of the Thames.*

By Lionel S. Beale, F.R.S., Treas. R.M.S.

(*Read* 10*th January*, 1884.)

Plates I.-IV.

The particles constituting the cloud-like masses of dark-brown and in some places black mud, held in suspension in the tidal water of the Thames and carried backwards and forwards by the tide, and which subside and form the soft mud which accumulates on the surface of the submerged banks, have always afforded objects of

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#### EXPLANATION OF PLATES I.-IV.

Plate I.

Fig. 1.—*Objects in Mud from Crossness Southern Outfall.*—*a*, muscular fibres which have passed through the intestine and have been partly dissolved by the digestive fluids, but which have undergone further disintegrative changes in consequence of the prolonged action of the Thames water upon them. In many of the muscular fibres the tranverse markings are still visible. At $a^{**}$ is seen a fibre in which the transverse striæ are very distinct, although the tissue is itself undergoing disintegration. $c^{*}$, a portion of a very small spiral fibre from vegetable tissue. *d*, crystals of fatty acids formed by the decomposition and oxidation of fatty matter. $d^{*}$, a collection of particles of carbon, probably soot. *f*, portions of yellow elastic tissue, probably from the areolar tissue of meat. *h*, portions of yellow fæcal matter in various stages of disintegrative change. In some of these masses are seen minute particles of sand and other matters which have adhered to the surface, or have become mixed with the soft viscid matter. *k*, a small piece of mica. *l*, a portion of myelin from nerve-tissue which has been long macerated in the Thames water. *m*, collection of bacteria. *n*, bacteria in the shell of a diatom.

Fig. 2.—*Also from Crossness Southern Outfall.*—*c*, large spiral vessels from vegetable tissue (common cabbage). $c^{**}$, two small spiral vessels still connected together as in their natural position in the tissues of the plant.

Fig. 3.—*From a mud-bank off Erith.*—*d*, crystals of fatty acids, the upper *d* a collection of crystals of fatty acids. $d^{**}$, a mass composed principally of oil-globules, with perhaps a little fæcal matter. *h h*, masses consisting of yellow fæcal matter with a few oil-globules. *i*, a glistening mass of very hard fatty matter. *k*, a minute fragment of mica.

interest to microscopical observers. To give an account of the diatoms only among the many constituents of this mud it would be necessary to recount the numerous memoirs published upon this important and highly interesting class of organisms from the time of Ehrenberg. I would venture to direct attention to the observa-

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PLATE II.

Fig. 4.—*Bodies found in mud from Barking Outfall.*—*a*, fragments of muscular fibre, partly dissolved by the action of the digestive fluids. The specimen on the left still retains its transverse striæ very distinctly. *c*, portion of spiral fibre of vegetable tissue, free from membrane. *f*, fine fibres of yellow elastic tissue, probably from areolar tissue of meat taken as food. *h*, portion of yellow fæcal matter undergoing disintegrative change.

In the following figures in plate II. objects found in mud from *a sewer close to Woolwich Pier* are represented.—Fig. 5, fragments of deal wood. Fig. 6, *a*, muscular fibres exhibiting transverse striæ very distinctly, with the exception of one, *a*, in the lower part of the figure to the right, which is a representation of a very small fragment partly dissolved. *d*, crystals, probably of fatty acids, set free by the decomposition of fatty matter. *e*, sporules of fungi. *f*, fibres of yellow elastic tissue. *g*, a collection of granules, probably altered fæcal matter. Fig. 7, *a*, fragments of muscular fibres in various states of disintegration. Fig. 8, *c*, spiral fibres from vegetable tissue; the lower figure represents a portion of a fibre set quite free from its enveloping membrane.

PLATE III.

*From an outfall of a sewer near to Trinity Ballast Office.*—Fig. 9, *a*, muscular fibres acted upon by the juices of the alimentary canal in much the same condition as when they left the body with the fæcal matter to pass into the sewer. Fig. 10, *d*, free crystals of fatty acids resulting from the decomposition of fatty matter. Fig. 11, *c*, spiral fibres from vegetable tissue. Fig. 12, *a*, muscular fibres partly acted upon and disintegrated. *h*, epidermis from a leaf.

*From a mud-bank off East Greenwich.*—Fig. 13, *a**, muscular fibre partly dissolved but still showing a few transverse markings. *d*, crystals of fatty matter with some fæcal matter. Fig. 14, *d*, fragments of white fibrous tissue, much decomposed and rendered granular by the action of the water and disintegrating agencies. *f*, portion of thick yellow elastic tissue from the coat of a large artery. Fig. 15, *h*, portions of stercoraceous matter with granules and oil-globules imbedded in them.

PLATE IV.

*From a mudbank off East Greenwich.*—Fig. 10, *o*, fragments of coal. *r*, epithelial cells, probably from the mouth. Fig. 11, very fine fibres of yellow elastic tissue.

*From a mudbank at Chelsea.*—Fig. 12, *a*, muscular fibre much disintegrated. *h*, masses of yellow fæcal matter undergoing disintegration by the action of the water.

*From an outfall of a sewer near to Trinity Ballast Office.*—Fig. 13, *c*, fragments of spiral vessels from vegetable tissue. *d*, crystals of fatty acids set free by the decomposition of fatty matter. A collection of the same is represented in Fig. 14 at *d*. *e*, sporules of fungi. *f*, fibres of yellow elastic tissue, many exhibiting transverse markings produced by boiling old fibres.

*From a mudbank at Chelsea.*—Fig. 14, *c*, vegetable cells with spiral fibres. Fig. 15, *s*, a portion of cellular tissue from some vegetable, probably turnip. Fig. 16, *p*, fragment of white fibrous tissue much disintegrated and with numerous granules therein. *a**, a portion of muscular fibre nearly transparent from maceration, but a few transverse markings still remain distinct. *f*, a small fragment of yellow elastic tissue showing vestiges of transverse markings. *o*, fragment of coal. Fig. 17, *a*, portion of muscular fibre changed by maceration. *o*, fragment of coal. Fig. 18, *o*, fragments of coal. Fig. 19, portion of a very large mass of fæcal matter containing many silicious and other fragments imbedded in it, and which adhere to the viscid matter of which it is in great part composed.

*Fig. 4.*

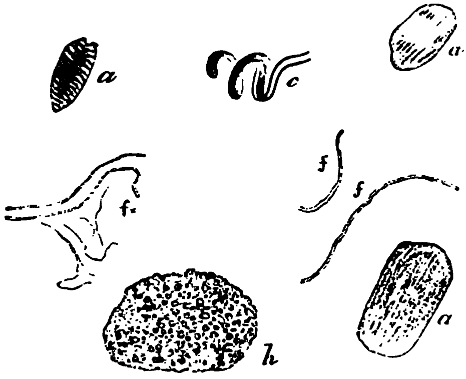
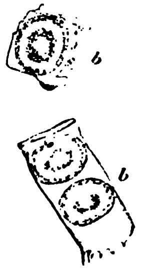


*Fig. 5.*



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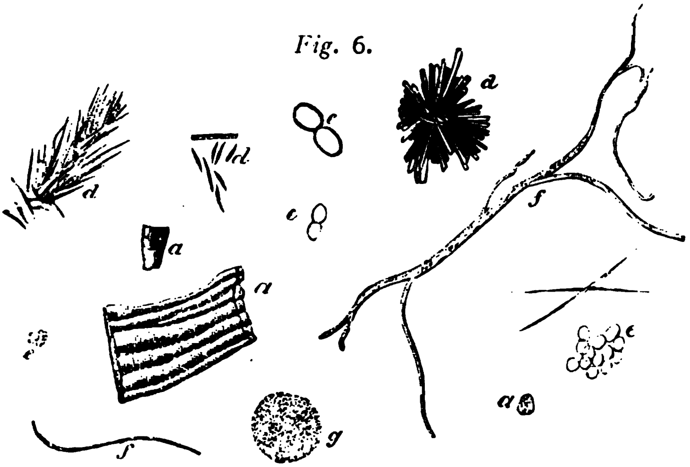


*Fig. 7.*

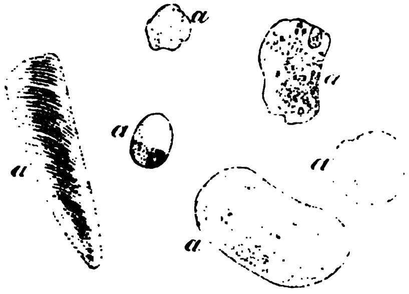
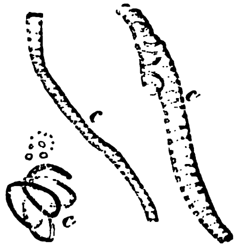


*Fig. 8.*



L. S. B. ad nat. del. 1883.

*1/1000 of an inch* |–| × 215 diameters.

*Fig. 9.*

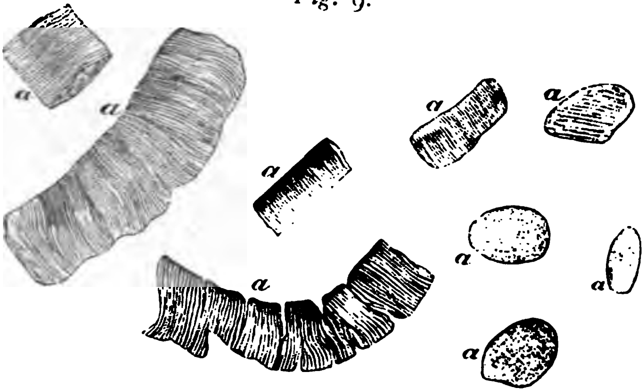


*Fig. 10.*

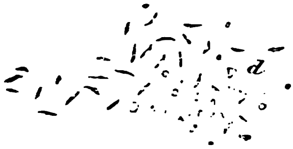


*Fig. 11.*

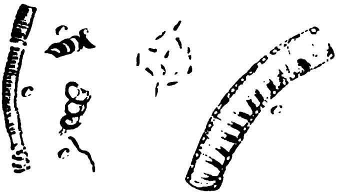
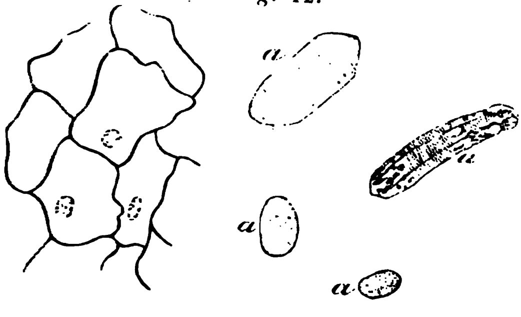


*Fig. 12.*



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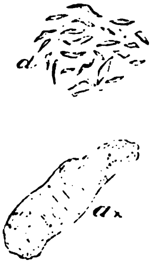

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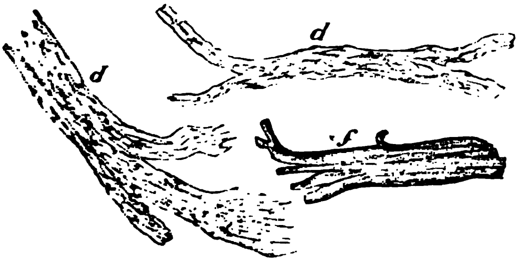
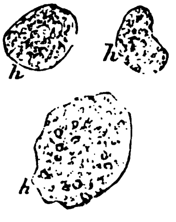


*Fig. 15.*



**L. S. B. ad nat. del.** *1883.*

*1/1000 of an inch* × 215 diameters.

*Fig.* 9.

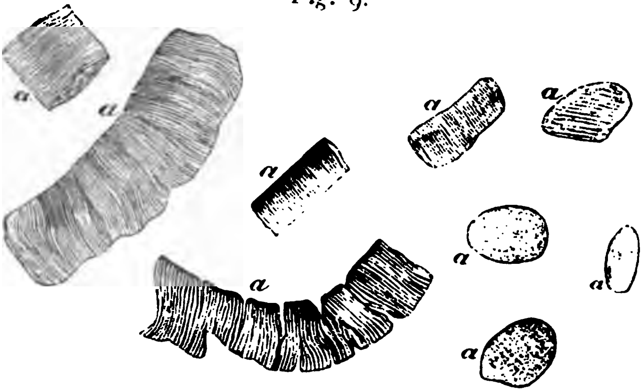


*Fig.* 10.

*Fig.* 11.

*Fig.* 12.

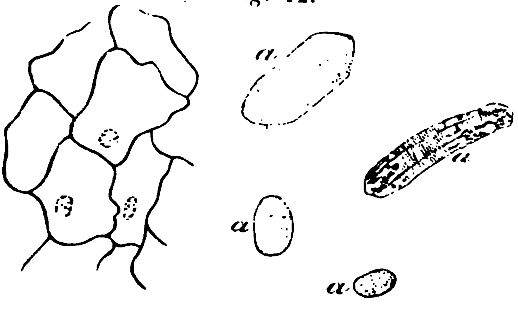


*Fig.* 13.

*Fig.* 14.

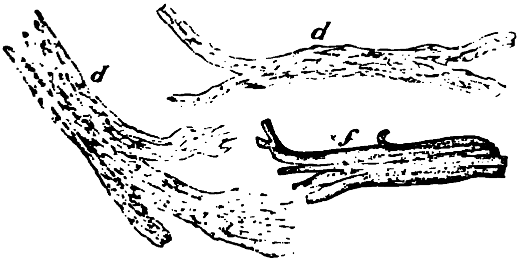
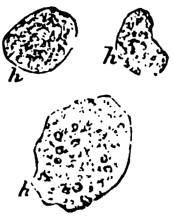


*Fig.* 15.



L. S. B. ad nat. del. 1883.

*1/1000 of an inch* |—| × 215 diameters.

Fig. 10.

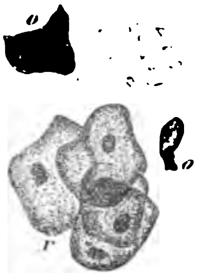
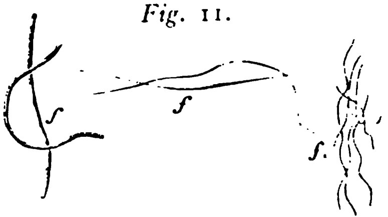


Fig. 11.



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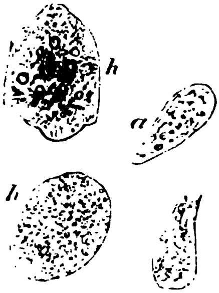


Fig. 13.

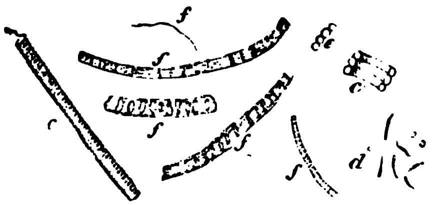


Fig. 14.

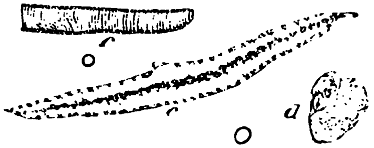
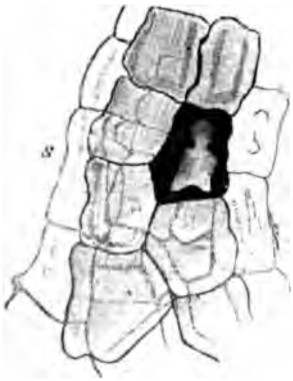


Fig. 15.



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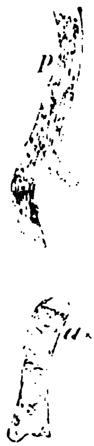


Fig. 17.

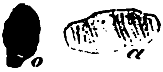


Fig. 19.

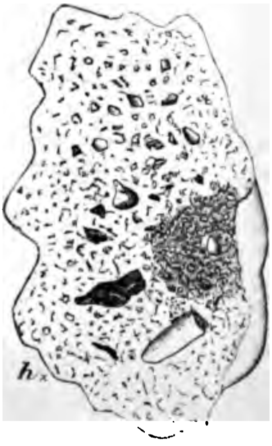
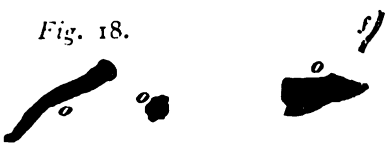


Fig. 18.



L. S. B. ad nat. del. 1883.

1/1000 of an inch ⌊. ⌋ × 215 diameters.

tions of this authority upon the diatoms of the Elbe, to those of Mr. T. F. Bergin on the deposits of the mud of the Liffey,* to those of Professor Bailey on the diatoms found in the Mississippi, to the paper of Mr. F. C. S. Roper on the Diatomaceæ of the Thames,† and lastly to the memoir of Dr. Bossey on 'Thames Mud in relation to Sanitary Science.'‡ Mr. Roper in 1854 and Dr. Bossey more recently have carefully studied the species of diatoms in different parts of the river, and have shown that the valves belonging to fresh-water species growing in the upper parts of the river may be carried down by the tide towards the mouth of the Thames, while the valves of those living in salt or in brackish water are to be traced as far up as the tide extends. These beautiful silicious skeletons so easily recognized and identified, being very light, are carried backwards and forwards by the tide, and are deposited on the mud-banks. They may be regarded as evidence of the course taken by other light particles suspended in the water of the river, and afford one of many indications of the movements of the sewage. Thus we are able to show that at any rate the least dense of the constituents of sewage may be carried from the outfall at Barking up to the first lock in one direction and below Gravesend in the other.

It is impossible to exaggerate the importance of investigations concerning the course of the sewage in the river considered in connection with the changes effected in it by various agencies during its suspension and after its subsidence as mud. That our river is fouled by the presence of sewage is patent to every one, while most of us feel that its state is a disgrace to our city. The serious question which presents itself to Londoners, and indeed concerns England, is whether this constant pollution of the river by the pouring into it daily of more than 100 millions of gallons, nearly 450,000 tons, of sewage can be continued without increasing risk to the health of the people, to say nothing of the disagreeable effects on the senses of sight and smell, and the very unpleasant considerations suggested by the contamination.

Some years ago there was unmistakable evidence of the occurrence of a very nasty kind of decomposition proceeding in the Thames water. The air of all the streets bordering the river was polluted with offensive odours. During the last few years, however, we have not been so seriously annoyed. But it must be borne in mind that we have had a remarkable series of cool and wet summers, favourable to excessive dilution of the sewage and unfavourable to organic decomposition. What the state of things would be if we had a very dry hot summer succeeding to a spring with less than the usual rainfall it is not pleasant to contemplate, for I am afraid it is probable that the considerable reduction of the volume of water in proportion to the sewage would result in a concentration of the dissolved and suspended organic matters, which, gradually rising in temperature from day to day to 70° or higher, would perhaps almost suddenly undergo a form of putrefactive change resulting in the setting free of large volumes of highly fetid gases, which would poison the air far and wide. Such a nuisance might persist for weeks, and only disappear when by the autumn rains the tidal water had become greatly diluted and its volume increased by fresh water pouring in from above. How far such a state of the river would be injurious to health it is not possible to say. I do not think anything of the kind upon so large a scale has ever happened, and any suggestion as to possible danger to health, not being backed by actual facts, would only excite counter observations and assertions as to the excellent health enjoyed by those who spend much of their time in the sewers, and a review of facts, carefully selected by no impartial hand, with the object of convincing people that stinks were not unwholesome, and that possibly to the trained they might be actually enjoyable; that the presence of decomposing animal and vegetable matter suspended in water was rather an advantage than otherwise; that countless multitudes of harmless organisms while ministering to their own enjoyment and advantage, exerted a beneficent influence by appropriating the products of disintegration just prior to decomposition; and that upon the whole we ought to consider ourselves fortunate in possessing in our midst a large river reeking with filth, because in this way the noxious substances are slowly resolved into simpler gaseous and soluble matters instead of the whole contributing to increase the already sufficiently ample mud-banks, which—and at a constantly accelerating rate—would add to the difficulties of navigation, and at length interfere with the passage of all but the smallest craft.

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* 'Cooper and Busk's Microscopic Journal,' ii. (1842) p. 68.

† Trans. Micr. Soc. Lond., ii. (1854) p. 67.

‡ 'Proceedings of the Holmesdale Natural History Club,' December 12th, 1879.

### *Method of Examination.*

The large amount of gritty silicious particles, as well as their considerable size, renders the examination of small portions of mud just as it is obtained from the mud-bank very difficult. The layer placed on the glass slide and covered with thin glass will be too thick for examination by any but the lowest powers, and in consequence, some of the most minute but most important of the constituents of the mud will not be discerned. If a little of any specimen of mud be mixed with water, covered with thin glass, and then examined in the usual way, nothing but large sand-grains, with here and there black particles of coal or carbon, will be seen. By mixing a small portion of mud with a considerable quantity of water, stirring it up, and then pouring off the upper part of the fluid after allowing a few seconds for the subsidence of the heaviest and coarsest particles, a deposit may be obtained in a state fit for examination under tolerably high magnifying powers, and if the process be repeated again and again, the mud may be separated into several portions differing from one another in density and in the coarseness of the gritty particles. But this plan is found not altogether satisfactory, for many of the organic substances in the mud are only imperfectly seen, while it will be impossible for the observer to form any idea of the relative proportions of the various constituents of the mud thus divided into separate portions differing from one another as regards the size and lightness of the component particles.

After having tried many different methods of investigation, I found that admixture with an equal quantity of glycerine afforded the best results. In this process the specimen can be kept for a length of time without undergoing change and be submitted to examination at intervals. The refracting property of the glycerine enables the observer to make out details of structure which could not be seen in specimens immersed in water, while in each specimen almost all the constituents of the mud are rendered clearer and more distinct.

Another important advantage is gained by this method of examination, inasmuch as the observer is able to form a notion of the relative amount of the several substances in each specimen examined, and also the relative amount of each in any given specimen. By this plan every constituent of the mud may be seen in one preparation, and specimens prepared in this manner have the additional advantage of preserving their characters for many years without change.

If a portion of the mud is simply mixed with water and then stirred up, the heavier particles allowed to settle while the lighter ones are poured off into another vessel and then allowed to subside, a very wrong idea may be formed of the number of the lighter substances present, because nearly the whole of these in the quantity of mud operated upon may be separated, and the microscopical specimen would in that case appear as if it consisted almost entirely of this one class of constituent particles.

This paper is based upon the results obtained by the microscopical examination of twenty-five specimens of mud from various banks between Gravesend and Chelsea taken under the direction of Dr. Collingridge, the Port of London Sanitary Officer, in the course of an inquiry undertaken at the request of the City of London for the purpose of obtaining evidence to bring before the Royal

Commission appointed to consider the question of Thames Pollution. I have received permission to communicate the results to the Society, and to publish them.

The observations made by me relate chiefly to the organized constituents of the sewage which can be demonstrated in the mud of the Thames by microscopical examination. Many of the particles found in the mud have been identified as substances which had entered into the formation of human excrements. I have endeavoured to ascertain what changes some of the most important of the fæcal constituents undergo in their passage from the houses along the drains into the river until their disintegration is at last completed or they have been deposited and form part of the mud banks of the Thames.

The broad and important fact which is, in my judgment, fully established by the investigation is this—that several constituents of human fæces are present in all the specimens of mud submitted to examination. The amount of these differs considerably, though no adequate means have been discovered of making an accurate estimate of the quantity of any one of them, or of instituting more than a very rough comparison between the muds obtained from different banks.

It must be borne in mind that the river mud is continually undergoing change in its character, the surface of the bank being often washed away, and old matters being mixed up with the elements of recent sewage; these being deposited together in other and perhaps distant banks, as determined by the varying quantity of water, the rate of its flow, and a number of other circumstances. Thus the mud of any given bank will vary considerably in its characters at different periods of the year, and it is quite supposable that a bank, which at one time would be found to consist of nearly pure sand, at another might seem to be almost entirely composed, at least on its surface, of the blackest and foulest organic matter undergoing rapid putrefactive changes.

It is well known that the quantity of organic matter in the mud is small. If a certain portion of the mud be dried and then exposed to a red heat for a time, the loss in bulk owing to the total destruction of the organic matter and the dissipation of all volatile substances is very slight. On the other hand it is to be remarked that neither the disagreeableness nor the danger to health of organic matter in a state of decomposition is dependent upon or varies according to the amount present. From a quantity of certain forms of organic matter so small that it would fail to turn the most delicate balance, as for example a fraction from the specimen of sewage taken from an outfall near Trinity Ballast Office, an odour of a most detestable character might emanate and be diffused over a considerable area. But it must be borne in mind that as regards animal and organic poisons dangerous to life, it is an admitted fact that a quantity easily carried by a very small fly might be sufficient to infect a considerable number of persons; and therefore the fact of the small proportion of organic matter in the Thames mud and in suspension in Thames water cannot reasonably be adduced as an argument in favour of its innocuousness or of its unimportance. But the relative proportion of the organic matter as well as its deleteriousness no doubt varies greatly at different times. I believe all the specimens of mud examined by me have been taken when the river was in flood, or soon afterwards, and at a time of the year when putrefactive decomposition is slowest. From the state of things under these favourable conditions it is hardly possible to determine how very unsatisfactory might be the state of the mud and of the river in hot dry weather. Year by year the actual quantity of sewage must increase, while the amount of water remains the same. In recent years the amount of water in the river and the rainfall have been above the average. At this time (November–December 1882) the degree of dilution is no doubt ample in proportion to the amount of sewage flowing into the river, but even under these favourable conditions disintegration is a very slow process. As the sewage poured into the Thames remains diffused in the water for a substantial time, at some periods of the year the putrefying sewage will be in too large a quantity in proportion to the water in which it is suspended to be properly disintegrated and oxidized, and in too concentrated a form to be appropriated by living animals.

## *Constituents of Food found in Thames Mud.*

Of the constituents of human food altered by the process of digestion and by subsequent maceration and disintegration, and by oxidation, not a few are to be found in the mud of the Thames, deposited from the water as it flows up and down the river. It might be supposed that in consequence of the long distance traversed in the sewers and the length of time during which they are suspended in the tidal water, few of the matters in question would be obtained from the mud-banks in a state in which they could be recognized with any certainty by microscopical examination. But in fact a number of bodies with well-marked and unmistakable characters have been found. Among these may be mentioned starch-granules, fragments of vegetable tissue, large spiral fibres of various plants, but particularly of common cabbage, all of which have already passed through the alimentary canal. Tea-leaves, fragments of cooked muscular tissue and yellow elastic tissue in a state in which one often finds them in fæcal matter, cotton fibres, probably from paper, fatty matter, and crystals of fatty acids. Even blood-corpuscles of man or of one of the higher animals have been detected in the mud, having withstood all the destructive agencies to which they have been exposed during probably many months. Fragments of paper and rags and many other things are also present, but it is to those substances which are found in the excrements that my attention has mainly been directed.

## *Fragments of Vegetable Tissue in Thames Mud.*

In every specimen of mud examined many fragments of vegetable tissue have been found, but considerable variation exists in different banks, both as regards the character as well as the quantity of vegetable tissue present. Some of the fragments of vegetable tissue found in the mud of the Thames are doubtless derived from plants which grow on the banks, and which in various ways and from many sources find their way into the river; but that the great majority of such fragments are derived from the sewage and have already passed through the alimentary canal is proved by the yellow colour they have taken from the fæcal matter. If healthy fæces be examined after a person has eaten a quantity of cabbage or other vegetable, many fragments of vegetable tissue stained of a deep yellow colour will be found, and the appearance of these is very similar to that of many of the fragments seen in my specimens of mud taken from the mud-banks. It is remarkable that, in its passage through the intestines, colourless greenish or pale-brown vegetable tissue becomes infiltrated with yellow colouring matter, and is thus sometimes deeply stained of a bright yellow, and this stain is very persistent.

## *Spiral Vessels.*

In nearly all the specimens of mud I have examined I have found fragments of spiral vessels, many of which are very large and of great length. The majority are undoubtedly derived from the common cabbage, while some are clearly connected with portions of tea-leaves, of which numerous fragments have been discovered in most of the specimens submitted to examination.

If a portion of the stem of a well-boiled cabbage-leaf be examined numerous large spiral vessels exactly like those I have found in the mud will be discovered. In most of them the membrane of the vessel is destroyed or so softened by boiling that the spiral fibre protrudes, and in many cases is almost entirely uncoiled. On comparing these spiral fibres with many of those in the mud the similarity will be at once recognized. The resisting power of the spiral fibre is shown by the fact of its retaining its remarkable characters not only after prolonged boiling, but after it has been exposed to the action of the digestive fluids poured into different parts of the alimentary canal, after it has passed through the sewers, and after it has been carried backwards and forwards by the tide, and exposed perhaps for months to various disintegrating actions constantly taking place on the mud-banks of the Thames. Spiral vessels, plate I. figs. 1 *c**, 2; plate II. figs. 4 *c*, 8; plate III. fig. 11; plate IV. figs. 13 *c*, 14.

### *Starch-granules.*

In several specimens of mud I have found starch-grains, and have been able to distinguish wheat starch, potato starch, and rice starch by the shape and size of the grains and by the action of iodine. Many specimens of wheat starch are much altered, and look as if partly digested. These I think have probably been derived from bread, and have passed through the alimentary canal. Starch has also been found in many cells of vegetable tissue, the exact nature of which I have not been able to determine.

### *Muscular Fibres.*

In almost every specimen of Thames mud examined by me muscular fibres or bodies which were recognized as the result of changes in muscular fibres were found. The fragments varied much in number as well as in size in different specimens of mud, but were most numerous and the anatomical characters of the fibres most distinct in the sewage taken direct from the mouth of the sewer and in the muds near the outfall. Many of the fibres were firm and hard, and had all the character of muscular fibres which had escaped the action of the digestive fluids in their passage along the alimentary canal, and which are very frequently, though not constantly, found in fæcal matter. The fibres in question are for the most part derived from beef. It is most interesting to study the changes which may be observed in the character of the fibre as it passes from the condition in which it is found in recent fæces, with its well-known and remarkably well-marked anatomical characters, to its final disintegration in the river and on the mud-banks of the Thames. Some of the most remarkable alterations in the microscopical characters of the fibres are illustrated in my preparations and represented in my drawings. In fresh fæcal matter some of the fibres exhibit the ordinary character of coagulated and well-cooked muscle tissue which has escaped the action of the gastric juice and intestinal fluids. The transverse markings are very distinct and are sharply defined, the fibres are firm and hard, and bear considerable pressure without being damaged.

In other specimens the action of the digestive fluids upon the fibres is very manifest, all appearance of transverse striæ being lost and the substance of the fibre appearing clear and jelly-like and of a faint yellow colour. Some of these transparent yellow masses are evidently undergoing disintegration and are pervaded by minute granules. Actual bacteria, which are active agents in destruction, are also often present in great numbers. In the muds of different banks it is not difficult to find examples of muscular fibre which illustrate every stage of disintegration up to the final conversion of the substance of the fibre into adipocere. Some of the fibres are probably softened at the time they leave the body. These are soon further disintegrated, silicious and other particles adhering to them; and the compound masses thus formed are gradually and at length completely disintegrated. Fragments of muscular fibres in various stages of disintegration are represented in plate I. fig. 1 *a*; plate II. figs. 4 *a*, 6 *a*, 7; plate III. figs. 9, 12 *a*, 13 *a**; plate IV. figs. 12 *a*, 16 *a**, 17 *a*.

### *Yellow Elastic Tissue.*

Many fragments of different kinds of yellow elastic tissue are found in the mud-banks of the Thames. This substance long resists decomposition, and it is probable that many months or even years may elapse before some of the firmest particles are completely disintegrated. The characters of elastic tissue vary according to the texture from which it has been derived. The fibres differ so much in structural peculiarities that it is often possible by microscopical examination to say whence they had been derived. I have identified fibres from the ligament of the neck, probably of the sheep, yellow elastic tissue arranged as a network from the coats of a large artery from the same animal, fibres from the lung and from the areolar tissue of the body. Not only so but some of the yellow elastic fibres in my specimens exhibit those peculiar transverse markings which show the fibres to be old and also indicate that they have been well cooked. (Plate IV. figs. 13 *f*, 16 *f*.) Yellow elastic tissue, it seems, passes through the alimentary canal without being acted upon by the digestive fluids and is therefore always found in the fæces when it has been taken with the food. Portions of yellow elastic tissue are represented in plate I. fig. 1 *f*; plate II. figs. 4 *f*, 6 *f*; plate III. fig. 14 *f*; plate IV. figs. 11, 13 *f*, 16 *f*.

### *Yellow Fæcal Masses.*

Among the most striking constituents of Thames mud are yellow granular masses varying much in size. The smallest of them are mere granules or small collections of very minute granules, and less than 1/100,000 of an inch in diameter, the largest as much as the 1/50 of an inch in diameter or even more.

These yellow masses have been described by Dr. Tidy in a Report to the Conservators of the river Thames, written in the year 1881.

The colour of these masses varies from a dull or dirty brown to a bright yellow colour. Some are smooth and homogeneous in parts, others rough and irregular containing particles of many different kinds, some of which have been associated with the yellow matter from the first, while others have been added while the matter was in the sewer or in the river.

As portions of fæcal matter are driven backwards and forwards by the tide, besides undergoing disintegration as has been already described, the opposite process of integration is also going on. The collection and aggregation of particles of many different kinds to form oval masses is always taking place. These composite masses consist of numerous minute particles of sand, many fragments of carbon, small portions of diatoms, oil-globules, fatty acids, and many other things apparently cemented together by the yellow viscid substance which forms an important constituent of fæces. Many of these compound masses are as much as the 1/50 of an inch in diameter.

Incessant changes, mechanical as well as chemical, are continually proceeding in the organic matter of sewage, but, as has been shown, these changes are not purely destructive and disintegrative.

It may be said that all the animal and vegetable tissue and other constituents of fæces with actual fæcal matter present, do no harm because they are constantly being disintegrated, while many low vegetable and animal organisms live at their expense and grow and multiply exceedingly and consume them. It may be said that by these means and by oxidizing and other disintegrating processes, all the organic matters present in sewage are gradually resolved into substances which are not in the least degree deleterious either to fishes and other organisms living in the water of the Thames or to the inhabitants of the houses near the river. Such statements may be made and supported by facts. Arguments telling in the same direction may be freely admitted without the strong objections to the presence of these things in a tidal river being in the slightest degree diminished, much less removed. Yellow fæcal masses of various sizes are seen in plate I. figs. 1 *h*, 3 *h h*; plate II. fig. 4 *h*; plate III. fig. 15 *h*; plate IV. figs. 12 *h*, 19.

### *Fatty Matter, Oil-globules and Fatty Acids.*

The fatty matter varied much in different specimens of mud. It existed in the form of amorphous granules, in globules, and as crystalline particles probably consisting of fatty acids set free in consequence of decomposition. Many compound masses were made up of granules and globules of oily matter, minute granules of silicious and other inorganic substances, fragments of vegetable tissue, starch-globules, all connected together by a viscid cementing substance of a yellowish colour which was probably the fæcal matter already referred to.

Such complex masses no doubt slowly undergo disintegration. By mere attrition the organic matter on the surface would be gradually removed and would form at length a very fine mud which would slowly settle, while probably a smaller portion would be subjected to chemical change and be ultimately dissolved. Fatty matter and crystals of fatty acids are seen in plate I. figs. 1 *d*, 3; plate II. fig. 6 *d*; plate III. figs. 10, 13 *d*.

### *Particles of Soot and Coal.*

There is no difficulty in discovering minute pieces of coal in the mud, and in some instances I have found indications of vegetable structure in the sections and delicate fragments of coal which have accidentally resulted from the action of the water and the rubbing together of particles as they were driven backwards and forwards by the current.

Much of the soft black matter present in the mud is no doubt soot. Even particles of silica are sometimes found soot-stained. Perhaps such black sand is derived from the smoke-impregnated granite débris of the macadamized roads. Black particles of coal and other forms of carbon are represented in plate I. fig. 1 *d**; plate IV. figs. 10 *o*, 16 *o*, 17 *o*, 18.

### *Diatoms.*

More than 100 different species of diatoms are found in the Thames, some being peculiar to fresh water, some to salt water, while the natural habitat of some specimens seems to be water which is always brackish.

The silicious skeletons of the valves of diatoms that have died, and multitudes of fragments of valves in every degree of disintegration are found in Thames mud. After the removal of the particles of sand a considerable portion of the inorganic matter of the mud that remains probably consists of the débris of the valves or shells of these organisms.

As long ago as 1853 Mr. F. C. S. Roper published some interesting observations on the 'Diatomaceæ of the Thames' * and gave a list of 104 species from the mud of the Isle of Dogs alone. Of these 30 are decidedly marine, 29 belong to brackish water, and the remaining 45 are fresh-water species. As would be supposed, some of the marine species are carried up the river, and the fresh-water species downwards towards the sea. Mr. Roper found marine species at Hammersmith, but very few fresh-water species were met with as low as Gravesend. "At Gravesend, out of 47 specimens 8 only are decidedly peculiar to fresh water, whilst at Hammersmith we find there are 29 fresh-water species out of a total of 43, showing however that the influence of the flood tide, even at that distance from the sea, gives a decided character to the diatomaceæ deposited by the water."

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* Trans. Micr. Soc. Lond., ii. (1854) p. 67.

Of the diatoms met with in Thames mud, some are found in a living state, but the majority are not only dead but they do not belong to the particular locality where their remains have been discovered. The silicious shells or valves of these organisms are very light and are often transported long distances. Suspended in the moving water, many pass up and down the river and probably form a part now of this bank, now of that. By this continual movement, and by rubbing against sharp particles of sand and by being buried in it, and then again disturbed, such delicate structures necessarily become disintegrated, and are at last broken into those very minute silicious fragments which exist in great numbers in the mud of all the mud-banks examined.

Mud-banks, especially on the surface, are in a state of constant change. Formation and destruction, accretion and disintegration are continual, and, when the facts are considered, one cannot feel surprised that organisms which are formed high up or low down the river, or at least parts of them, should eventually be discovered in a resting place at a long distance from the seat of their development. Bodies formed high up the stream may be deposited at its mouth, and those which inhabit the sea or brackish water may be carried far up into the region traversed by and exposed to the action of fresh water only. In fact, the ascent and descent of light particles is clearly shown by the distribution of the diatoms on the banks in different parts of the river, and this fact alone would render it certain that many of the constituents of sewage would in like manner be carried up and down by the tide, and that some would be found a long way from the point where they first entered the Thames.

### *Bacteria.*

are found in immense numbers in all the muds I have examined, and exist in multitudes in Thames water, and in connection with all the particles of organic matter held in suspension in the water, or which have subsided to the bottom, or have fallen on the leaves of plants or other objects which have prevented their further subsidence. Bacteria are so very minute that they may easily be passed over unless a very thin stratum of the fluid which holds them in suspension be examined. Though so small, they are probably bodies of the very highest importance in the disintegration of sewage compounds. The germs of these organisms are excessively minute, many being less than the 1/100,000 of an in. in diameter, whilst the smallest are probably not to be seen when amplified by the highest magnifying powers at our disposal. So very small are they that they must grow for some time before they are of a size sufficient to be rendered visible by an objective which magnifies upwards of 5000 diameters. Bacteria germs exist everywhere in countless multitudes, not only in air and in water and on the surface of every kind of matter, but in the interior of bodies living as well as non-living wherever fissures exist, and chinks are seldom absent through which germs so minute can pass. Not only are bacteria always to be found upon every part of the surface of all living beings, but they exist within the blood, and in the very substance of the tissues however distant from the external surface of the body, and however far from any direct communication with the outside air. In all animals and in all plants, at all temperatures consistent with life—in every part of the world—bacteria are living at this moment, and they have lived, and probably in the same way as they live now, in every period of the world's history from the earliest dawn of life. Soon after the death, and in many instances long before the death of a man or an animal has taken place, the bacteria germs, which have been dormant in the tissues and fluids, begin to grow and multiply enormously, so that in a very short time every part is freely pervaded with countless hosts which soon stop all ordinary action and efface all characteristic structure. Then begins that long series of changes which ends at last in the formation of products of comparatively simple character and very stable nature.

Extremely minute division of the organic matter of sewage and its equable diffusion through a large volume of water in constant motion are favourable to the conversion by bacteria, of noxious matter into chemical compounds, which are inodorous and harmless, and which undergo but slight change whether moist or dry, and which are usually at last disposed of by becoming the food of plants. In the case of sewage this desirable change into innocuous compounds is rendered very slow in consequence of the matter not being spread out in a sufficiently thin layer to be quickly appropriated by the bacteria.

The rate of growth and multiplication of bacteria varies greatly at different periods of the year. These organisms are not destroyed by ordinary cold; nay, there is evidence that bacteria multiply after having been exposed even to intense cold, but of course very slowly as compared with their rate of increase under favourable conditions. The changes effected by them on the products resulting from the death of man, the higher animals, and plants, are, and probably have ever been, the same in their essential nature at all times, but a longer time is required for the completion of the changes in cold than in warm weather.

Although chemical change, irrespective of the action of living forms, and especially the action of oxygen, undoubtedly plays an important part in the disintegration and reduction to simpler and more stable compounds of some of the constituents of sewage, particularly the excrementitious matters of the human body, by far the most extensive changes, and those effected on the largest scale, are brought about by these minute organisms. Bacteria are among the lowest and simplest living forms in nature, and as I have mentioned are universally present, or at least are to be found wherever moisture-laden air exists. Some forms of these bodies do not even require oxygen for their subsistence. They can live in nitrogen, carbonic acid, and probably in gases of the most poisonous and deleterious character for a length of time, though they do not grow and multiply quickly until conditions favourable to them are established.

In the present state of knowledge it is not possible to explain precisely how these organisms act upon the offensive sewage matter, but it is probable that as they grow and multiply they actually feed upon and consume the noxious material. After living its life the bacterium dies, and the products arising from its decay and disintegration are harmless indeed as compared with the substances upon which it has fed, and which for the most part it is our great anxiety to be rid of. The matters resulting from the disintegration of bacteria in turn become the food of plants. If not taken up by vegetation these compounds would remain passive as a soft brown granular material which is stable, and undergoes scarcely any change whether it remains constantly moist, as in mud, or sometimes dry and sometimes wet as the humus of earth. Few organic substances undergo so little change from century to century, nay, from age to age, as for instance those products of plant decay which constitute the principal constituents of various kinds of peat. The same may be said of the last products of the decay of animal matter. For after the offensive gases which characterize the ordinary putrefactive change of animal matter have been evolved, and the putrefactive process has run its course, slow evaporation takes place, and, after hundreds and thousands of generations of bacteria have passed through the several phases of existence and have died, there results a brown substance which preserves its characters for centuries, and probably undergoes no further change at ordinary temperatures.

In the disintegration of the substances resulting from the death of the higher plants and animals there is no doubt that many forms of life take part, but when at length these have lived and disappeared, bacteria continue the processes, and it is, as I have remarked, by their action that the organic matter is caused to assume its final form in which it may remain for any period innocuous to all forms of life. The brown matter which remains after decay has run its course, consists mainly of the lifeless remains of bacteria.

Disintegration by bacteria begins in the living organism itself. There is no part of the alimentary canal or of any of the ducts, tubes, or cavities opening into it, in which multitudes of these organisms, growing and multiplying in countless millions, cannot and at all times be found. It has undoubtedly been assumed by many observers that whenever bacteria are discovered in the cavities, tissues, and organs of living animals they have been introduced from without. But the assumption and the conclusions based upon it are erroneous, as any one who will make the investigation with due care may easily convince himself. In the cavity of the mouth they are always and in all states of health in all animals growing and multiplying excessively. Even in the interior of the cells of plants, cabbages, lettuces, watercresses, &c., as well as in the interstices of the inmost tissues of the higher animals and of man, they or their germs exist, and when the conditions become favourable, they grow and multiply in enormous numbers. Many of the bacteria present in the water and in the mud of the river have no doubt been derived from bacteria which existed in the excrementitious matter before it left the organism in which it was formed. These probably go on growing and multiplying in the organic matter while in the Thames, and are not the least important agents in its disintegration and ultimate resolution into harmless compounds.

## *Practical Considerations.*

In conclusion, I shall venture to make a few observations concerning the practical inferences which are suggested by the present inquiry. Although no doubt a physician is likely to take a rather limited, fragmentary, and possibly not impartial view of many of the most important matters which bear upon the great question of the proper disposal of sewage, while to effectually grapple with the difficulties, engineering knowledge and skill are required which none but the trained engineer can possess, it nevertheless seems permissible, and since no harm can thereby result, I think it may be desirable that those engaged in other departments of the inquiry should briefly give expression to their views. The subject is one which cannot receive too much consideration before the mode in which it is to be practically dealt with is decided. I have often wondered whether, besides the Thames, there is another river in the world, on the mud-banks of which could be found in equal quantity, particles of fæcal matter, fragments of muscular fibre in every stage of disintegration, fibres of yellow elastic tissue, spiral fibres from vegetables, and many other constituents of food which have passed through the human intestinal canal, with other organic matters in a state of decomposition, discharged as sewage, to undergo disintegration in the river, and there become resolved at last into harmless matter.

It is said with truth that London is the healthiest city in the world, but the possibility that our river may any summer seriously damage our reputation must not be lost sight of: year by year the proportion of sewage to the water increases, and the particular point at which the sewage contamination becomes dangerous to health is unknown, for there is no experience to guide us, while so many circumstances contribute to the maintenance of its present harmless condition on the one hand, and such comparatively slight departures from the ordinary conditions might cause disaster on the other, that the problem is one of the most complex and difficult that could be presented for solution; while it is doubtful whether the precise changes that would endanger the public health could be discovered by experiment and determined beforehand. In fact there is much uncertainty, though little ground for satisfaction.

Granting for a moment the correctness of all that has been said in favour of the state of the river at this time, granting that at present the sewage is carried away, there remains the important question whether without very considerable changes the removal of the sewage in the course of a few years will be as efficiently carried out as it is now. The amount of sewage is constantly increasing, the amount of water by which it is diluted remains the same. Must not the time come when the proportion of sewage to the water becomes so large that its disintegration and harmless decomposition within the proper time will be impossible?

As long as the sewage is passed into and immediately mixed with a very large volume of water, our drainage system is no doubt very effective, possibly as near perfection as can be expected in a case where the removal of the sewage of a population of four millions has to be provided for. During the greater part of the year the sewage is no doubt sufficiently diluted as it passes along the sewers, while these are well scoured by the flow through them; but when little rain-water is added to the water supplied by the companies, what will be the state of the sewage? So far, therefore, from the surface rain-water being diverted and prevented from passing into the sewers, every arrangement ought to be made to facilitate its flow into and exit from them.

The smell of the river and of the mud some years ago, when the amount of sewage poured into the Thames probably did not amount to more than half the quantity now traversing the sewers, perhaps affords some idea of what might happen if the conditions favourable to the development of smell were repeated and augmented in intensity, as will probably obtain when a very dry hot summer follows a winter and spring in which the rainfall shall have been considerably less than the average, unless in the meantime some more effectual and quicker means of disposal of the colossal amount of the sewage should be discovered and carried into practice. As London increases, therefore, every effort should be made to keep up and increase the amount of water mixed with the sewage at its source so that it may attain the greatest degree of dilution that is practicable during its transit along the sewers.

Any one who has seen the vast volumes of water in the upper Thames during the time of flood will be convinced that there is water and more than enough to flush the sewers of a city even considerably larger than London. If only a small portion of this vast quantity of wasted water could be husbanded till the time approaches when the amount at our disposal for diluting the sewage could be thus supplemented, the efficiency of the present system would doubtless be greatly increased. Unless the plan for dealing with the sewage can be completely changed, it will be necessary, as time goes on, to further enlarge the present sewers, to divert into them sewage which even now finds its way into some of the tributaries of the Thames, and to carry further and further towards the sea the mains which receive the sewage and drainage collected from that increasing area included in Greater London. That such operations would entail vast and lasting expenditure is obvious, but basing our conclusion on the practical results achieved during the past thirty years and more, is it not highly probable that all that can be desired would be gained? On the other hand, it may be asked which of the several other suggested schemes of sewage disposal has been found to succeed on a sufficiently large scale, and for a sufficient length of time, to justify its adoption in place of the main drainage system now in operation?

By mixing sewage with large quantities of water the gradual disintegration and oxidation of many of its constituents and the slow conversion of all its deleterious principles into substances which are at any rate harmless, is insured. The changes are in part mechanical and chemical, and partly due to living organisms, which play no unimportant part in the ultimate reduction of noxious organic matters to harmless compounds. The rapidity and completeness of the purification of the contaminated water in great measure depend upon the degree of dilution. If the sewage is concentrated, the decomposition which ensues is of a different kind and results in the formation of compounds of a most offensive and deleterious kind, which are afterwards only very slowly converted into harmless substances. If the sewage passed into the sea in such a manner that it became quickly diluted, it is probable that for miles round, at a considerable distance from the outlet, organisms of many kinds would grow and multiply in vast numbers. Many of these would become the food of fishes, which in their turn would be taken and help to support the population which had already supplied their sustenance.

That objections may be advanced to some of the details of the drainage system now in operation is no doubt true, but the experience of many years has conclusively proved that it is workable, and the results of its working may, I suppose, be considered fairly satisfactory. The practical working of the main drainage system seems to have shown that if only sufficient quantity of water for dilution can be provided, and a good outlet to the sea obtained, the sewage of a city, however large, might be quickly and thoroughly disposed of, and the sanitary condition of houses, however numerous, at least as far as sewage is concerned, assured, while the alterations rendered necessary by the gradual increase of population, could be carried out from time to time as required, by the enlargement of the sewers and their extension towards and into the sea.

## II.—*On the Mode of Vision with Objectives of Wide Aperture.*[*]

By Prof. E. Abbe, Hon. F.R.M.S.

(*Read 12th April*, 1882.)

The idea of "all-round vision" as a peculiar capacity of wide-angled lenses has been put forward with opposite aims. The object of one side has been to indicate an *advantage* of wide aperture-angles in the vision of *solid* objects, depending on the angles *quâ* angles and the admission of rays from all sides of the object at the same time. The other opinion claims that this must be a *disadvantage*, constituting an unnatural mode of vision, causing particles to look spherical (when sufficiently minute) even if in reality cubes, and giving rise to a confusion of dissimilar images.

The tacit supposition of both views is, that the optical conditions of microscopical observation are essentially the same, even with the minutest objects, as those of naked-eye vision—that a solid object is depicted through the Microscope in the same perspective, in which it would appear to the eye in ordinary vision, if it were looked at *in the direction of the delineating pencils.*

They assume, for example, that a minute die *a b c d* (fig. 1) if depicted by means of oblique pencils *r* (such as are admitted through the marginal zone of a wide-angled objective) will appear in the microscopic image with the perspective in which it would be seen by an eye in the direction of *r*. It would thus appear as the projection of the die on a plane P *perpendicular to the direction r*, or, which is the same thing, as if it were placed in an *inclined position* on the stage under axial illumination (fig. 2).

Fig. 1.

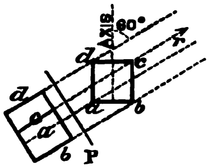
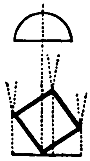


Fig. 2.



In fact it is supposed that obliquity of the delineating pencils to the axis of the Microscope is equivalent to and produces the same effect, in regard to the manner of projection of the image, as an oblique position of the object under perpendicular (axial) incidence of the pencils, and on the basis of this view the natural conclusion of course is that as a wide aperture admits pencils of very different obliquities at the same time, the resulting image must embrace as many different perspectives of the solid object, depicting them to the observer's eye at the same time, just as if many narrow-angled objectives (or eyes) A, K, Z, &c. (fig. 3) were arranged around the object and their images united.

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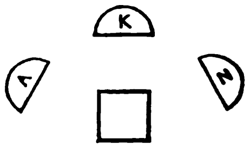
[*] The paper (received 3rd March 1882) is written by Prof. Abbe in English. Its publication has been delayed pending the completion of Prof. Abbe's paper in the last volume.

FIG. 3.



According to the point of view adopted, or to the private taste of the writer, this, as I have said, is considered either as an advantage of wide-angle vision, or as a drawback.

The fact is, however, that neither the one nor the other of these views is correct, because no delineation of the objects takes place in the manner supposed. This is shown by the following consideration, which also shows at the same time the error of the view that the resultant image of an objective of wide aperture is composed of ***dissimilar*** images projected by rays of different inclinations, for this is based on the same hypothesis essentially as the others just referred to.

First consider the case of a *plane* object. The course of the rays through a wide-angled objective is shown in fig. 4, the object being at A B. If we suppose the objective to be well corrected (or aplanatic) all rays emanating from the axial point A (i.e. the *whole* pencil $a$) will be collected at *one* point $A^*$, and the same is true not only for an axial point, but for an eccentric point B also (up to a certain moderate distance from the axis at least).† Consequently the whole pencil $\beta$ from the point B will be collected also to one distinct point $B^*$ of the image.

Now it is an evident inference that the plane A B must be delineated exactly in the same manner (as the *same* plane $A^*$ $B^*$ of the image) whether it is delineated by the two *axial* pencils $a\,a$ and $\beta\,a$, or by any two oblique pencils $a\,m$ and $\beta\,m$, whatever be their inclination to the plane of the object. For if *all* rays from B are collected to the same point $B^*$, the two partial pencils $\beta\,a$ and $\beta\,m$, which are parts of the whole pencil $\beta$, cannot be collected to different points.

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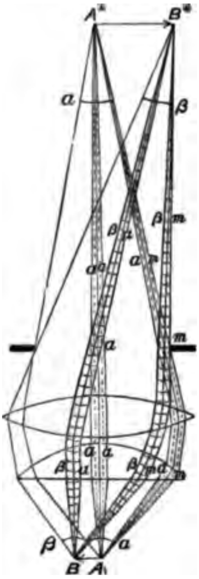
† This idea of a well-corrected system has been considered formerly as quite unconditional. It has been supposed that whenever the rays from the *axial* point A are collected to a sharp focus, the rays from excentrical points B would always be collected to sharp foci by themselves. I showed in 1873 that the latter is *not* a necessary consequence of the former, and that a particular condition must be fulfilled in order to have the same collection of rays from excentrical points as is obtained from an axial one when the spherical aberration is corrected. This condition is the *law of aplanatic convergence*—proportionality of the *sines* of the angles at the foci A and $A^*$.

Thus it is certain from the simple notion of an aplanatic system that pencils of different obliquities must yield *identical* images of every plane object or of a single layer of a solid object. However large an aperture may be, the resultant image of the object cannot therefore be composed of *dissimilar* images, and the wide aperture cannot be the cause of confusion, &c.

We see also at the same time that the delineation of an object through the Microscope does not exhibit differences of perspective according to the obliquity of the delineating pencils to the plane of the object, as is the assumption of the all-round vision theory. The image of any plane surface A B (e.g. the upper surface of the minute die) is always the same whether the rays are admitted to the Microscope in perpendicular or in any oblique direction. If that theory was right, the image of A B, by the oblique pencils *a m* and *β m* ought to be shorter (according to the perspective shortening of the lines in oblique projection) than the image by the axial pencils *a a* and *β a*, as we should of course have a shorter image of A B if we observed it through a low-power Microscope with inclined axis.

Fig. 4.



*a* the *entire* pencil starting from the axial point A of an object, and collected to the axial point A* of the image.

*β* the *entire* pencil starting from an excentrical point B collected to the excentrical point B* of the image.

*a a* and *a m* an *axial* and a *marginal* elementary pencil from A which are contained within the pencil *a*.

*β a* and *β m* corresponding *axial* and *marginal* elementary pencils of the whole pencil *β*.

The two *axial* pencils *a a* and *β a* pass through the central part, *a*, of the clear opening: the marginal pencils *a m* and *β m* touch the margin of the opening at *m*.

The limiting diaphragm of the clear opening is assumed to be at the plane of the posterior principal focus (as is always the case approximately with high powers) in order to obtain the corresponding rays of the two pencils *a* and *β parallel* in front of the system, or the *same obliquity* of *a m* and *β m*.

This absence of perspective shortening of the lines according to the obliquity of the rays exhibits therefore an essential geometrical difference of microscopic vision, which renders it uncomparable to macroscopic observation.

Secondly, consider the delineation of a *solid* object such as a minute die.

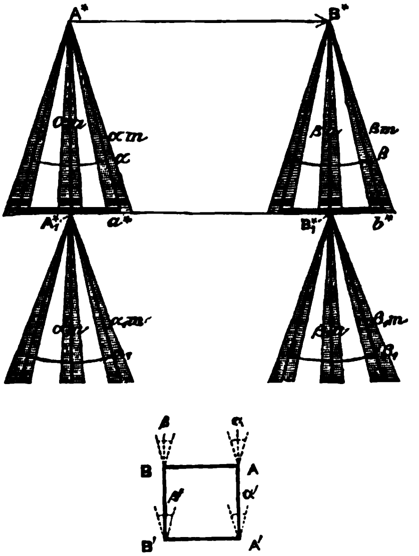
This is of course perfectly defined by determining the delineation of the upper plane surface A B, and of the lower $A_1$ $B_1$ (fig. 5). The result of the previous consideration must apply to both plane surfaces successively, provided their distance along the axis is sufficiently small. For in this case, an objective which is aplanatic for the conjugate points A and B will still be aplanatic for the neighbouring pair of conjugate points $A_1$ and $B_1$.

Consequently the *whole* pencils $a$ and $\beta$ from the surface A B will yield a distinct image $A^*$ $B^*$ at a certain plane, and at the same time the *whole* pencils $a_1$, and $\beta_1$, from the other surface $A_1$ $B_1$, will also project a *distinct* image $A_1^*$ $B_1^*$ at another (lower) plane.

Suppose (1) that the image is delineated by means of *narrow axial* pencils $a\,a$ and $\beta\,a$, and the ocular focused to the exact level of the lower layer $A_1^*$ $B_1^*$. The points $A^*$ and $B^*$ of the upper layer will in this case appear as *small* dissipation circles projected upon the distinctly seen points $A_1^*$ and $B_1^*$ of the lower layer, the centres of these circles coinciding with the latter.

Suppose now (2) the image to be delineated by the whole aperture, i. e. by the *wide* pencils $a$ and $\beta$, and the ocular focused to the lower layer as before. The points of the upper image, which is not exactly focused, will now give much broader dissipation circles projected on the sharply seen points $A_1^*$ $B_1^*$ but the centres of the two sets of points will still coincide.

Fig. 5.



$\begin{pmatrix}A^* & B^*\\ A^*_1 & B^*_1\end{pmatrix}$ air image of the object $\begin{pmatrix}A & B\\ A_1 & B_1\end{pmatrix}$ as projected by the objective to the field of the ocular.

The diagram shows the manner in which the two successive layers A B and $A_1$ $B_1$ of the object are delineated by means of the *whole* pencils (full aperture pencils) $a$, $\beta$ and $a_1$, $\beta_1$, or by means of the *elementary* pencils $a\,a$, $\beta\,a$, and $a_1a$, $\beta_1a$, or $a\,m$, $\beta\,m$ and $a_1m$, $\beta_1m$, and indicates the manner in which the image of the upper layer is seen projected upon the image of the lower layer. The thick lines indicate the diameters of the circles of indistinctness which represent the points $A^*$ and $B^*$ under various circumstances at the plane of the *lower layer* (in one case broad and in the other small) on the assumption that this lower layer is exactly focused and seen in perfect distinctness.

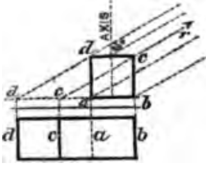
What is the difference between these two cases? The small dissipation circles in the first case may still be capable of affording a pretty distinct vision of the upper layer at the same time as the lower, and we say that the depth of the object is within the range of the depth of distinct vision *for pencils of narrow aperture.* The broad dissipation circles resulting from the wide pencils of the full aperture will in all probability render the image of the upper layer very indistinct, so that the image of the *whole* object will appear indistinct also. The *causa efficiens* of this indistinctness is simply too great a depth of the object compared with the small depth of vision attendant upon a wider aperture. If we take a similar solid object, but of *much smaller depth,* we should see its upper and lower layers in sufficient distinctness, notwithstanding the wide aperture.

Consequently the indistinctness of an object which is not quite flat if observed with a wide aperture, does not arise from any dissimilarity of the images by axial and by oblique pencils, but solely on account of the *reduction of the depth of vision.*

Suppose now (3) an image projected by *narrow oblique* pencils *a m* and *β m* through a marginal or intermediate part of the aperture. The sharp images of *both* layers A B and $A_1$, $B_1$, will be exactly the same as the sharp images by the axial pencils *a a* and *β a*, or the sharp images by the whole pencils *a* and *β*. But as these images occur at different planes they will show a *parallactic displacement.* If the ocular and the eye are focused to the level of $A_1^*$ $B_1^*$, the points $A^*$ and $B^*$ will appear projected to the points $a^*$ $b^*$ and will be seen as dissipation circles with those points as centres. We have once more always similar images, only displaced horizontally.

This must give rise to a mode of projection of solid objects which is essentially different from the ordinary *perspective* projection under oblique vision. Suppose the die (fig. 1) delineated at an oblique direction of 60°. A true perspective image, such as would be obtained by an eye receiving it in the direction *r*, or if the Microscope were directed to it in this direction, would give the projection on a ground plane *perpendicular to the line r.* But the image of the die as depicted by the oblique pencils in an objective of 120° aperture-angle will be a projection to a ground plane *perpendicular to the axis of the Microscope* (fig. 6), and not to the rays *r*. Both surfaces, *a b* and *c d*, will therefore be projected with their true diameter, but displaced horizontally, and not shortened as in fig. 1.

Fig. 6.

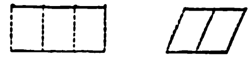


If we compare now the image of the solid object by the oblique pencils $a\,m$ and $\beta\,m$ to the image by the axial pencils $a\,a$ and $\beta\,a$, or to the image by other oblique pencils (say of *opposite* obliquity), we have dissimilar images. But this dissimilarity relating solely to the projection of *successive* layers, and being nothing else but different parallactic displacement of successive layers, cannot be effective in microscopic vision unless these images are produced by different portions of the aperture *separately*, that is, if the effective pencils (or the effective portions of the aperture) are separated, and the one conducted to one image and the other to another image, as is done by the various arrangements for stereoscopic vision. As long as various portions of the aperture are effective *at the same time*, producing *one* image, we have only an increase of the dissipation circles at those planes which are not exactly focused, and a reduction consequently of the depth of distinct vision. We have no "all-round *vision*" because *vision ceases* as soon as the "all-round" becomes effective.

The result of the whole consideration therefore is:—(1) In a well-corrected (or aplanatic) objective the images of a flat object by pencils of different obliquity are always strictly similar. The obliquity of the rays at the object does not produce any difference of perspective, as it does in ordinary vision, or when the same object is observed by a Microscope in an oblique direction. The Microscope therefore does not delineate solid objects perspectively, and has no capacity of all-round vision, either as a drawback or a benefit.

(2) The images of solid objects arise from the projection of their successive layers in perfect similarity, however large the aperture may be (refraction of the rays by structural parts within the layers disregarded). As long as the depth of the object is within the limits of the depth of vision corresponding to the aperture and amplification in use, we obtain a distinct *parallel projection* of all successive layers on one common plane perpendicular to the axis of the Microscope (a regular ground plan), either strictly orthogonal (fig. 7) when the delineating pencils, narrow or wide, are axial, or with a certain obliquity of projection if these pencils (i.e. the axes or principal rays of the pencils) are inclined to the axis of the Microscope. If the depth of the preparation is greater than the depth of tolerably distinct vision, this projection must become indistinct, because the layers above or below the range of distinct vision give rise to broad dissipation circles confounding with the distinct portion of the image. Since the depth of vision, other circumstances being equal, decreases with increasing aperture, good "definition" of wide apertures is confined to *thinner objects* than good definition of narrow apertures.

FIG. 7.



(3) **Dissimilarity of the images of *solid* objects by different parts** of the aperture is solely difference of projection (orthogonal projection *versus* oblique projection—or one degree of obliquity by axial pencils against an opposite obliquity by oblique pencils). It relates therefore exclusively to the manner in which *successive* layers are seen projected to the common ground plane (perpendicular to the axis of the Microscope) or to the *perception of the depth*, and not in any way to the delineation of the plane layers themselves. The effectiveness of this dissimilarity for microscopic *vision* is confined to the case of an actual separation of the images by stereoscopic apparatus; for if this dissimilarity should be *perceptible* and the partial images *not* separated (viewed by distinct eyes), the out-of-focus layers would appear confused, and no *vision* of the depth could be possible, as explained just above. We have, then, no advantage from the said dissimilarity.

(4) Stereoscopic vision in the Microscope is entirely based on the said dissimilarity of projection exhibited by the different parallactic displacements of the images of successive layers on the common ground plane of projection. There is no *true* perspective difference of the images by different portions of the aperture, because the microscopic image does not admit of a perspective shortening of the lines, which are oblique to the direction of the delineating pencils.

# SUMMARY

OF CURRENT RESEARCHES RELATING TO

# ZOOLOGY AND BOTANY

*(principally Invertebrata and Cryptogamia),*

# MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.[*]

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## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Influence of Gravity on Cell-division.**[†]—Dr. E. Pflüger's experiments were conducted with the eggs of the frog. Each egg consists of a dark and a light hemisphere, and after fertilization the dark hemisphere always comes to lie uppermost, the "axis" of the egg being therefore vertical. When the black hemisphere is uppermost the line connecting its middle point with the middle point of the white hemisphere is termed the "primary axis"; to the primary axis correspond, of course, a primary equator and meridian. The "secondary axis" passes through the point at which the first and second planes of cleavage cut each other. The "tertiary axis" finally is any perpendicular diameter of the egg that is not coincident with either of the two former axes. The first two cleavages pass through the axis of the egg, and the third cuts it at a right angle; the question therefore arises, is there any real connection between the direction of cleavage and the axis of the egg, or do the first cleavages pass through the axis of the egg because it happens to coincide with the direction of gravity? By preventing the rotation of the eggs, by fixing them to a watch-glass in various positions after fertilization, Dr. Pflüger was able to show that the latter interpretation is the correct one; the first cleavages do not follow the axis of the egg but the direction of gravity passes along the vertical diameter, whether it happens to coincide with the axis or not. In the normal egg left to assume its own proper position with the dark hemisphere uppermost, it is well known that the process of division is far more energetic in the upper dark hemisphere, and this was believed to depend upon some property special to this hemisphere. If, however, an egg be turned upside down during the process of division, it is found that the cleavage proceeds more vigorously in what is now the upper half and ceases to be so well marked in the lower half, and therefore clearly has nothing whatever to do with any special quality of different portions of the egg itself, but depends entirely upon its position.

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[*] The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

[†] Pflüger's Arch. f. gesammt. Physiol., xxxi. (1883) pp. 311–8.

Another point to which Dr. Pflüger directed his researches was the relation that exists between the first cleavage and the axis of the future embryo; the experiments made appeared to show that the two are identical, and that each of the two cells therefore formed by the first division corresponds to one half of the body of the future embryo: and also, a fact of the greatest importance, that the various parts of the body appeared to arise from the light or dark hemispheres according to the position of these latter; when the light hemisphere was uppermost the whole nervous invagination was seen to be clear and transparent. This part of the subject, however, the author does not consider to be as yet placed on a firm basis and intends to continue his investigations.

In a second paper on the same subject * the author notes that among the tadpoles developed from the eggs some were remarkable by the dorsal surface being entirely free of pigment, owing to the fact that the light hemisphere had been fixed in the uppermost position; later, however, the pigment seemed to spread over the whole body, and no recognizable difference between the dorsal and ventral surfaces could be detected. The albinos also showed occasional abnormalities and soon died. A further investigation was made upon the eggs of *Bombinator igneus;* the main results appear to be the following: Quite normal embryos were developed when the upper hemisphere had a larger clear portion; but if it became almost entirely made up of the clear hemisphere the embryos were abnormal and died, though it was perfectly evident that the axis of the egg might be at any angle whatever with the direction of gravity, and not interfere in the least with the early developmental stages.

In the earlier communication it was stated that the axis of the embryo coincided with the axis of the first cell-division, and that the central nervous system was formed out of the dark or the clear hemisphere, or out of both according to their position; a more careful investigation has shown that the central nervous system is always developed from the clear hemisphere.

This fact appears to show that the egg is after all not "isotropous," and that a given organ arises from some particular region of the egg entirely independently of gravity; but another series of facts tends towards the opposite conclusion; in eggs fixed in an abnormal position the anus of Rusconi was *never* to be seen upon the upper hemisphere; again, when the primary axis was inclined at an angle the medullary groove was always developed with the anterior end in the upper portion and the posterior end in the lower portion of the white hemisphere, which latter, of course, was also obliquely inclined to the horizontal. The position of the anus of Rusconi affords still further proof of a "relative isotropy"; it always appears upon the white hemisphere, and is intimately connected with the direction of the axes of the egg.

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* Pflüger's Arch. f. gesammt. Physiol., xxxii. (1883) pp. 1–79 (2 pls.).

The paper concludes with some observations on the development of *Marsilia* made by Dr. H. Leitgeb; it appears that in the embryo of this plant, the position of the first divisional septum in every case coincides with the axis of the archegonium; it is, however, capable of rotation round the latter, and as soon as the axis of the archegonium ceases to be vertical, takes such a position that the embryo is divided into an upper and lower half.

The occurrence of the same principle of development in two such widely different types is evidently an indication of its wide-spread importance.

**Influence of Physico-Chemical Agencies upon the Development of the Tadpoles of Rana esculenta.**[*]—E. Yung subjected tadpoles just hatched to the action of saline solutions of various strengths. The salts employed were obtained by the evaporation of the water of the Mediterranean, and the larvæ were placed in solutions of 1, 3, 5, 7, and 9 per 1000, which were renewed at the same time in all the vessels, and the whole were in other respects placed under precisely the same conditions. As a general result, M. Yung states that the tadpoles are developed the more slowly the more considerable the degree of saltness of the water. In the solution of 9 : 1000 no transformation took place, though some tadpoles live long enough to acquire hind limbs. In a solution of 10 : 1000 very young tadpoles die in a few hours: elder ones survive for a few days. The author remarks upon the importance of placing equal numbers of individuals in each vessel in experiments of this kind, as their development is found to be slower in proportion to the number living together.

M. Yung also subjected young tadpoles, which normally live in quiet water, to continuous agitation in a vessel containing two litres of water regularly renewed and suitable food. Under these conditions the eggs developed well; but the newly hatched tadpoles, being too feeble to seize their prey in so disturbed a medium, died of hunger, unless care was taken to give them daily a few moments of repose to take their food. If these tadpoles be compared, at different periods, with others of the same brood developing in quiet water, it is found that the developing of the former is slower, that they are less pigmented, which indicates bad nutrition, and, lastly, that their tails are relatively more developed, especially in width, which is explained by the greater use they are obliged to make of the organs in struggling against the waves.

**Colours of Feathers.**[†]—The colours of the feathers of birds are of two kinds: (1) *Objective*, that is, colours caused by the presence of definite pigment, or by structural peculiarities of the feather itself, or finally by both causes combined; (2) *Subjective* colours are caused by the various effects of broken or reflected light.

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[*] Arch. Sci. Phys. et Nat., x. (1883) p. 347. See Ann. and Mag. Nat. Hist., xiii. (1884) p. 72.

[†] Proc. Zool. Soc. Lond., 1882, p. 409.

The colours owing to the presence of pigment are always black, brown, and red of various shades; only one instance is known of a green colour produced by pigment, and that is in the feathers of the Touracous. The violet and blue tints are never due to pigment alone, and often depend merely upon lines and grooves on the surface of the feather. There are numerous colours which appear to be due to the combination of definite pigmentary bodies within the substance of the feather, and the structure of the feather itself, and this is the case especially with blue feathers. If one of the blue feathers of a Macaw be pressed and broken so as to destroy its structure it appears to be of a brownish grey colour, which is owing to the presence of pigment of that colour. Dr. H. Gadow has published some interesting observations upon these colours. He finds that the blue feathers of many birds consist of an outer structureless sheath, beneath which is a layer of "cones" covered by a system of extremely fine lines running parallel with the long axis of the cone; below these cones lies a layer of brownish-yellow pigment, which appears black when present in great quantity. The whole surface coating of the feather varies not only in different birds, but in the different feathers of the same bird, and is in any case too thick to allow of the blue colour being explained in the way that other colours are produced by thin plates. The fine ridges upon the cones seem to be the source of the blue colour.

The colours of yellow feathers are sometimes due simply to the presence of yellow pigment; but since many yellow feathers contain no pigment, this explanation will not hold in every case. In all probability a system of fine lines observed upon the outer surface of the feather is the cause. Similar lines occur in violet feathers, but they are finer and not quite so straight, and in this way, perhaps, the difference in colour is produced.

With regard to the green colour of many feathers, the suggestion of Krukenberg, that it is caused by an admixture of yellow pigment and a blue optical structural colour, is not a sufficient explanation inasmuch as most green feathers do not show the same peculiar structures that are met with in blue feathers. All the green feathers examined show the following structure: a transparent smooth sheath covers the barbs and barbules; beneath this is a system of ridges and fine pits; the ridges are less regular than those of the yellow coloured feathers; beneath this layer is yellowish or brownish pigment.

The second group of colours (subjective) are produced by a transparent sheath which acts as a prism. They are the so-called "metallic" colours, which change according to the position from which they are viewed. In describing the colours of birds a good deal of confusion has arisen from this fact, and Dr. Gadow suggests the desirability of introducing a standard method of describing these metallic colours in order to insure uniformity, and gives a diagram illustrating three positions in which the bird should be placed in order to describe its colours.

**Rudimentary Sight apart from eyes.***—Prof. V. Graber has instituted experiments to ascertain whether, and if so to what extent, eyeless and blinded animals are sensitive to light. As an example of the former he chose the earthworm; for the latter, *Triton cristatus.*

The worms were placed in a box containing a number of cells of equal size, each with front and hind wall made of glass; the whole box was further divided into three parts, each of which had two front and two hind windows; the latter were turned from the light; and one of the windows of each cell was darkened, or supplied with a differently coloured light from that of the others. At the bottom of each was placed a layer of mud not sufficient to conceal earthworms. Twenty to thirty worms were first put into each cell and the box placed with one side towards a window with a north light. The number of worms found on the light and the dark sides respectively were counted at the end of every hour, and were replaced by fresh every four hours. Seven readings show that 40 specimens were found in the light, and 210 in the darkened spaces, giving a proportion of five of the latter to two of the former.

Using opaque glass for one set of windows, 326 worms were found in the partitions thus relatively darkened, and 204 in the absolutely light ones. In employing light of different colours, care was taken that the one colour chosen should be very decidedly lighter than the other. As it soon became evident that red was more attractive to the worms than blue, a much darker shade of blue was chosen than that of the red; then in 12 divisions 193 specimens were found in the pale red light, and only 57 in the dark blue; this difference is the more remarkable as the worms, being naturally lovers of darkness, would, so far as *intensity* of light was concerned, have been expected to prefer the dark blue; it indicates an appreciation of the *quality* of the light. In like manner, white light, deprived of the ultra-violet rays, attracted 87, ordinary white light only 13 worms; of pale green and dark blue, the former colour attracted 138, the latter 42 individuals; of pale red and dark green, the former attracted 168, the latter only 72. In examination of a statement, that it is only the anterior end of the body which is sensitive to light, experiments were made upon worms deprived of this part to a length of four or five rings; they gave the proportion of worms found in the dark as 2·6 to 1 of those in the light, and that of those in red light as 2·8 to 1 of those in the blue—results tending in the same direction as those obtained from entire specimens. Applying the same method to newts, Graber found that while, of 160 uninjured specimens, only one was found in the light area, the rest being in the dark, 135 specimens from which the eyeballs together with a considerable length of the optic nerves had been removed, were found in the light, and 308 in the dark. The same result was obtained after the filling up of the eye-cavity by wax in some of the blinded animals, proving that the optic nerve had no action in producing this light-sensitiveness. Using coloured light, it was found that 192 normal specimens appeared to prefer pale red against the 8 in dark blue; of blind individuals, 536 were found in the first, and 406 in the latter colour; with colours of about equal intensity, 474 were found in the red, and 176 in the blue.

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* SB. K. Akad. Wiss. Wien, lxxxvii. (1883) p. 201. Cf. Naturforscher, xvi. (1883) pp. 437–9, and 'Journ. of Science,' v. (1883) pp. 727–32.

The proportion of individuals preferring a good light devoid of ultra-violet rays was as 2 to 1 of those found in darkish ultra-violet light; as between green and blue, the proportion was 3 to 1 of the respective colours for unblinded, and about $1\frac{6}{8}$ to 1 for blinded individuals. Thus blinded animals are shown to be sensitive to both quantitative and qualitative differences in light.

Graber considers the above facts to be in accordance with the theory of evolution of special optical organs (eyes) from generalized ones (skin); as the reactions of these hypothetical dermal organs resemble those of the former, and their inferior activity is quite natural. This agreement favours the interpretation of the phenomena as due to an inferior degree of vision, and not to the results of thermal or chemical influences acting on the animals experimented on.

## B. INVERTEBRATA.

**Nerve-centres of Invertebrata.**[*] —W. Vignal has examined the nervous system of various groups of the higher invertebrates and comes to the following, among other, conclusions:—

In the Crustacea the cells of the ganglia are nearly all unipolar, and almost always consist of a viscous granular substance, in which the nucleus is slightly and the nucleoli highly refractive. Bipolar and multipolar cells are also present. The nerve-fibres forming the connectives, the commissures, and the nerves have a proper wall, on the surface or in the interior of which there are oval nuclei; the inclosed substance is viscid and slightly granular, and contains a central bundle of fibrils, or the fibrils are isolated. The central nerve-chain and the nerves are invested in two sheaths, one of which is structureless, and appears to be of a cuticular nature, while the other is formed of imbricated lamellæ, which, in the macrourous crustacea, forms a partition in the connectives. The nerve-cells on the ventral face of a ganglion send off prolongations into its centre; this centre is formed of nerve-fibres, and of prolongations from the cells; the two are closely united and form a plexus whence the nerves are given off. The gastro-intestinal nerves are composed of fine fibres which have the same structure as those of the ventral chain. They form two plexuses, along which nerve-cells are to be observed.

In the Mollusca bipolar or multipolar cells are very rarely found among the cells of the ganglia, and this is especially the case in the Gasteropoda. The nerve-cells are formed of a ganglionic globe on the surface, and in the interior there are fine fibrils; among these are fine fatty granulations, which are sometimes variously coloured. The ganglionic globe, which has no investing membrane, contains a large nucleus and one or more nucleoli. The nerves and connectives are formed by fibres of very various sizes, which are separated from one another by partitions developed from the sheath of the nerve. The fibres themselves are made up of fibrils which are inclosed in a slightly refractive and feebly granular substance. The myenteric plexus forms, along the digestive tube, a triple plexus, on the branches of which ganglionic cells are irregularly scattered. The centre of the ganglia is formed by a fibrillar substance and a slightly refractive body, which is of the same nature as the peripheral matter of the cells; the central fibrils have no definite arrangement; the nerves arise from the centre of them. The envelope of the nervous system is formed by a lamellar connective tissue, which is composed of fine fibrils. Among the cells of the ganglia a peculiar kind of connective cell was observed; this was oval, and contained a large nucleus; from the two poles of the cell long fibrils are given off.

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[*] Arch. Zool. Expér. et Gén., i. (1883) pp. 267–408 (4 pls.).

In the Hirudinea all the ganglionic nerve-cells are unipolar; those of the gastro-intestinal system have the same essential structure but are not invested in a proper membrane, the sheath that invests them being part of that system which has been compared by Ranvier to Henle's sheath in vertebrates. The fibres that make up the nerves vary in size, and are separated from one another by thick partitions, and are composed of fibrils inclosed in a slightly granular protoplasm. The sympathetic system forms a double plexus along the digestive tube, and on its branches are developed ganglionic cells. The connective chain is formed by three nervous cylinders; no nuclei are to be seen either in the protoplasm of the connectives or of the nerves. No multipolar nerve-cells are to be found in the centre of the ganglia, as Walter and Hermann have imagined. The investment of the nervous system is a continuous sheath which is only open near the ends of the nerves.

The last group dealt with is that of the Oligochæta, and in it we find that the nerve-cells of the cerebral and ventral ganglia are mostly unipolar, and are formed of a viscous slightly granular substance. Near the homogeneous nucleus fatty granulations are to be found. Bipolar and multipolar cells are also to be observed, but they do not occupy any definite position. The nerve-fibres form the columns of the chain, have no proper walls, but are simply bounded by the partitions of connective tissue; these tubes are formed of a viscous and almost homogeneous substance, which is only feebly coloured by osmic acid; these fibres anastomose with one another.

The giant nerve-tubes are three in number, and extend along almost the whole length of the chain. The central, which is the largest, commences at the middle of the first ganglion, and the other two at the second; they end at the terminal ganglia. They appear to have no relation to the nerve-fibres.

The nerves have the same structures as the fibres of the columns.

The whole system (with the exception of the cerebral ganglia) is completely invested in three sheaths—epithelial, muscular, and structureless (of a cuticular character); the first and third are alone formed on the cerebral ganglia.

All the ventral ganglia give off three nerves on either side. The first is very sharply distinguished into two halves.

**Tracks of Terrestrial and Fresh-water Animals.**[*]—T. M'K. Hughes describes some peculiar markings on mud, the manner of formation of which he has been able to observe, and points out how they explain away difficulties which have arisen in the interpretation of certain fossil tracks, showing that some of the characters most relied upon to prove the vegetable origin of the fossil forms, such as branching, solid section, &c., could be produced by animals.

His observations were made on certain pits in the district about Cambridge which are filled with the fine mud produced in washing out the phosphatic nodules from the Cambridge greensand. As the water gradually dries up, a surface of extremely fine calcareous mud is exposed. This deposit is often very finely laminated, and occasionally among the laminæ old surfaces can be discovered, which, after having been exposed for some time to the air, had been covered up by a fresh inflow of watery mud into the pit. The author describes the character of the cracks made in the process of drying, and the results produced when these were filled up. He also describes the tracks made by various insects, indicating how these are modified by the degree of softness of the mud, and points out the differences in the tracks produced by insects with legs and elytra, and by annelids, such as earthworms. The marks made by various worms and larvæ which burrow in the mud are also described. Marks resembling those called *Nereites* and *Myrianites* are produced by a variety of animals. The groups of ice-spicules which are formed during a frosty night also leave their impress on the mud. The author expresses the opinion that *Cruziana*, *Nereites*, *Crossopodia*, and *Palæochorda* are mere tracks, not marine vegetation, as has been suggested in the case of the first, or, in the second, the impression of the actual body of ciliated worms.

**Growth of Carapace of Crustacea and of Shell of Mollusca.**[†]—A notice is here given of T. Tullberg's essay on this subject,[‡] in which he states that the carapace of the lobster is formed by the subjacent cells, the outer part of which becomes directly converted into the hard covering; the striation is due to the fibres being imbedded in the fundamental substance; these fibres are formed by the cells at the time when the enveloping substance is deposited.

On the other hand, the shell of the Mollusca is, for the most part, a secretion from the cells of the mantle, but there is, in addition, a substance which in structure calls to mind the carapace of the lobster, where, too, the outer part of the cells gives rise to the shell-substance. The operculum of the whelk appears to be formed in the same way as its shell.

The researches have been carried on in too few species to justify any general conclusions, but if we take into consideration the great resemblance which obtains between all chitinous formations, it hardly seems rash to suppose that they are all formed like the carapace of the lobster, while the great resemblance between the shells of Lamellibranchs and Gasteropods almost justifies the belief that their mode of formation is essentially the same.

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[*] Abstr. Proc. Geol. Soc. Lond., 1883, No. 443, pp. 10–11.

[†] Arch. Zool. Expér. et Gén., i. (1883) pp. xi.–xiv.

[‡] In K. Svenska Vetens.-Akad. Handl., xix. (1882).

**Commensalism between a Fish and a Medusa.**[*]—In a consignment from the Mauritius, G. Lunel found united *Caranx melampygus* and *Crambessa palmipes.* The fish stuck with the greater part of its body in the apertures which are formed by the four columns uniting the stomach with the nectocalyx, and traversed by the gastro-vascular canals. This union could not be explained by the hypothesis that the animal had sought out the other as its prey and means of nourishment. For the medusa belongs to a family which possesses no proper oral aperture, but only a series of microscopic pores, which can only take in very finely divided nourishment, and the fish had merely taken up his quarters in a natural hollow of the medusa, which was only enlarged, but in no way injured, by the long residence of the fish.

It was ascertained that the fisherman had taken the two animals together in that position; and that several years ago there had been seen on the coast, in a depth of about six inches below the surface, a fish of the same kind in conjunction with an anemone, and going in and out of it. The anemone into which the fish had entered was living, for it could be seen moving.

Lunel arrives at the conclusion that there are certain kinds of fish the fully grown individuals of which live at more or less considerable depths, whilst the young, either on account of an unknown peculiarity of their organization, or because they require a diet more congenial to their age, ascend with particular medusæ to the upper regions of the sea, to find there the countless small pelagic animals on which they and their hosts are nourished. It is noticeable that the fish, in order to enter the medusa, must swim upon its side, therefore in a very abnormal position.

**Symbiosis of Algæ and Animals.**[†]—K. Brandt states that the occurrence of yellow cells has now been observed in the following groups of animals:—Radiolaria, Anthozoa, Hydrozoa, Foraminifera, Flagellata, Ciliata, Spongiæ, Ctenophora, Echinoderma, Bryozoa, Turbellaria, and Annelida. He is able to add the following to the list of species in which they have been detected:—*Reniera cratera, Paralcyonium elegans, Aiptasia turgida, Echinocardium cordatum, Holothuria tubulosa* (larva), *Zoobothrium pellucidum*, and *Eunice gigantea.*

Besides yellow and brown algæ, others occur also in animals. Green algæ have been found in numerous rhizopods and infusoria, also in fresh-water sponges, hydrozoa, and turbellaria. Marine sponges also contain blue-green algæ, Oscillatorieæ, and red and red-violet Florideæ. Engelmann's researches on animal chlorophyll show that some modification must, however, be made of the conclusion at which the author had previously arrived, that the occurrence of chlorophyll in animals is invariably due to the presence of inclosed algæ.

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[*] Fol's 'Recueil Zoologique Suisse,' i. (1883) pp. 65–74 (1 pl.).

[†] Pflüger's Arch. f. gesammt. Physiologie, 1883, pp. 445–54. Cf. this Journal, ii. (1882) pp. 241, 322.

The yellow cells of different animals differ from one another very considerably in their structure; but all agree in possessing a chlorophyll-like pigment, a nucleus, and a starch-like product of assimilation. In almost all were found two different products of assimilation, viz. 1st, grains containing a vacuole, and therefore appearing like a ring in optical transverse section, never doubly refractive, always colourless or very pale blue, and coloured by pure iodine brown or violet, or, under certain circumstances, blue-violet; 2nd, compact granules, doubly refractive and of irregular form, of a reddish or violet colour, and not changed by treatment with iodine. The first of these is undoubtedly a substance allied to starch.

When large quantities of the green cells are carefully treated with filtered water, they usually assume the form of zoospores with two cilia at the anterior end; their pigments being still usually in the form of parietal plates, and having starch-grains in their interior.

Morphologically the yellow cells are very different from chlorophyll-bodies, and correspond to unicellular chlorophyllaceous algæ, while physiologically they behave altogether like chlorophyll-grains.

By a fresh series of experiments the author has confirmed the view previously held that the hosts or "phytozoa" make use, for their own nutrition, of the products of assimilation which the algæ obtain in excess through the influence of light.

## Mollusca.

**Skin of Cephalopoda.***—P. Girod regards the dermis of cephalopods as being essentially formed of connective tissue, the cells of which may become the centre for the formation of reticulated tissue, connective bundles, pigment-cells, or the so-called *iridocysts*. We find two strata, one formed of pigment-cells which are motile chromatophores, the other of iridocysts. The former is the most interesting, and has been very extensively studied. For its further comprehension it is well to distinguish the two constituent parts of the chromatophore: the *pigment-cell*, which is nothing else than the central spot, filled with coloured granulations, and the *radial bundles* which form a complete crown around the cell. The chromatophore, thus constituted, moves in a space which may be called the *peripheral space*.

The pigment-cell varies in size according to the degree of contraction or expansion of the chromatophore. The basal cell of the radial bundle is rounded during contraction, elongated and flattened during expansion. The fibres which make up the bundle approach one another during contraction, and separate on expansion. The interfascicular spaces are elongated during contraction, wider and flatter during expansion. Girod denies the contractile muscular nature of the radial bundles, and regards them simply as formed of connective tissue. It is clear, therefore, that, on this view, the bundles cannot be regarded as taking any active part in the expansion of the chromatophores. Their importance lies in their being the agents for the fixation of the pigment-cells in the layers which they occupy. The contraction of the chromatophore is due rather to the elasticity of the capsule and the contraction of the basal cells; the expansion of the cell seems to be due to its protoplasm.

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* Arch. Zool. Expér. et Gén., i. (1883) pp. 225–66 (1 pl.).

The layer of iridocysts is formed of a series of plates formed from the primitive connective-tissue-cells; they have a central nucleus, and are made up of a number of rods. Where the iridocysts are only arranged in one layer they are more closely packed.

In the developmental history of the layer of chromatophores the first point is the conversion of certain cells into pigment-cells; around these other cells become grouped; the intermediate cells then increase in number, or form fresh pigment-cells, and new "common cells," which, in their turn, are capable of proliferation. The pigment-cell, once constituted, grows rapidly, though the nucleus remains of the same size all through the period of growth. The limiting cells divide, and so increase in number till there are from twenty to thirty of them. The radial bundles are formed by the striation of the cells of the peripheral reticulum.

**Development of Gills of Cephalopods.**[*]—L. Joubin describes the gills of *Sepia officinalis* as commencing under the form of two small rods placed symmetrically in relation to the antero-posterior plane, and in the middle of what will become the posterior wall of the pallial cavity. The bud, which is primitively due to an outgrowth of the epithelial layer, soon elongates, becomes rounded at its tip, and attached by a wide base. The bud then flattens, and its hinder face becomes applied to the visceral mass, while the anterior is still covered by the mantle.

One and then a second fold, and afterwards others, appear on the bud, and these form depressions on one surface which correspond to elevations on the other. Although these folds increase in number they do not occupy the whole face of the young gill; along its edge there remains a space, and in the anterior of these an efferent vessel is developed, and in the posterior the special branchial gland.

Any one elevation may be regarded as a semicircle formed of three parallel arcs of cells. If these be fixed at their extremities, and if the arcs were to grow equally, we should soon have a large, deep, and more or less conical cul-de-sac. This is not, however, what happens. The cells of the median layer increase in number, and push forwards the epithelium of the convex surface, while that of the concave remains unaltered; the middle layer soon forms a stratum invested on either side by the convex epithelium; the cells of this stratum, which at first touched one another, soon become separate, and give rise to intermediate lacunæ and vessels.

Each of the layers thus formed gives rise, in its turn, to a series of transversely disposed elevations, which soon form hollow outgrowths, this time on either side. Finally, in the adult there is a third series of outgrowths, which do not appear till the embryo is about to leave the egg.

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[*] Comptes Rendus, xcvii. (1883) pp. 1076–8.

The efferent blood-vessel is early developed, occupies almost the centre of the organ, and is contained in the base of the layers and of the branchial gland. The efferent vessel is developed on the crest of the gill and on the outer edge of the layers just described; it has the same undulating course as the parts which carry it, and is, at the base of the gill, directly continuous with the auricle of its own side.

**Further Researches on Nudibranchs.**[*]—R. Bergh prints an important paper, illustrated by five plates, as a supplement to his monograph of the family of which *Polycera* Cuvier is the typical genus.

After a number of general notes on species and genera, among which is the description of *Ohola*, a new genus collected by the 'Challenger,' at Trapura, in the South Seas, the author considers the Dorididæ in general, with their divisions and probable phylogeny. The genus *Heterodoris* of Verrill and Emerson is considered as probably belonging to a different family. The Dorididæ are separated into two very well marked groups by the possession of a single large retractile crown of gills, or of numerous retractile branchia: Cryptobranchiata and Phanerobranchiata respectively. The latter, connected with the typical Dorididæ through *Staurodoris*, diverge in two lines, of which the more ancient forms are *Notodoris* and *Akiodoris*. The former culminates in *Placamophorus*, with *Ohola* as a lateral branchlet. The latter passes through *Acanthodoris*, *Goniodoris*, &c., towards *Ancula* and *Drepania*.

The phanerobranchiate, non-suctorial Dorididæ form the Polyceradæ (better Polyceratidæ) of Bergh, and the suctorial forms his Goniodorididæ. A synopsis of the genera and species of these groups is given. They inhabit all seas, but are largest and most beautiful in the warmer regions.

**Functions of the Renal Sac of Heteropoda.**[†]—L. Joliet was able to notice on a living *Phyllirhoe* that the renal sac was folded, and that it opened slowly; this movement was clearly due to the action of the cilia of the pericardiac orifice. When the sac was full its own orifice opened slowly, remained visible for some seconds, and then disappeared. In the Firolidæ there is a system of external muscles, by means of which the renal organ may perform a true diastole. The author addressed himself to the problem whether the water taken in this diastole entered into the pericardium, or whether, on the contrary, water passed out from that cavity. The results of his observations of living forms were to convince him that the water which bathes the renal cavity does not enter into the pericardium, and that it is the function of the renal sac to extract liquid from the blood, to expel it to the exterior, but not to draw water from without to pass it into the blood. In fine, we must agree with the teaching of Lacaze-Duthiers, that an organ whose principal function is to secrete the products of excretion, cannot be well looked for in the course of currents which pass into the organism, but may be well sought for along a line of centrifugal currents.

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[*] Verh. Zool. Bot. Gesellsch. Wien, 1883. Cf. Science, ii. (1883) p. 748.

[†] Comptes Rendus, xcvii. (1883) pp. 1078–81.

**Interstitial Connective Substance of Mollusca.***—J. Brock finds that the interstitial connective substance of molluscs is very ordinarily found in the region of the central nervous system, and of the great nerves and vessels lining the inner surface of the cœlom, and on and between the viscera; the amount present varies greatly in different species, being, for example, richly developed around the central nervous system of Opisthobranchs, though very sparsely so in Pulmonates; while the conditions are reversed when we come to examine the viscera. The author deals in detail with *Aplysia punctata*, *A. fasciata*, *A. depilans*, *Pleurobranchus* sp., *Pleurobranchæa meckeli*, *Helix pomatia*, *H. nemoralis*, *Limax agrestis*, and *Arion empiricorum*.

The observations of those who have studied the embryology of the Mollusca appear to make it certain that, in the later stages of their development, a large quantity of spindle-shaped or branched mesodermal cells are to be found in the cœlom; it is from them that, in all probability, the connective substance is derived. To connect the one with the other it is only necessary for a homogeneous intercellular substance to be secreted; by means of their processes the cells come into connection with one another, and so give rise to the network. Other cells increase in length and break up into fibrils, and thus the whole body becomes traversed by a connected network of nucleated bundles of fibrils, which are surrounded by a plexus of unaltered mesodermal cells. Yet other cells become altered in composition, and become filled with carbonate of lime or concretions of an indefinite character. If this be the mode of genesis of the interstitial substance the lowest conditions are to be found in the Opisthobranchs; the plasma-cells are exquisitely delicate bands in *Pleurobranchæa*, and large compact cells with sharp processes in *Aplysia punctata*.

With regard to the vexed question of the cellular lining of the cœlom Broch comes to the following conclusion: the Enterocœlia always have a peritoneal epithelium which is derived from the endoderm, and which, therefore, represents a true epithelium; the Pseudocœlia have either no (?) cœlomic epithelium, or a true endothelium (Mollusca) which is derived from the mesoblast and has the morphological value of cells of connective substance. This character may be distinctly retained, as in Opisthobranchs and Pulmonata, or may attain to a higher degree of differentiation, and taking on the form of a true epithelium obscure its original character, as in Prosobranchs (? all) and in Cephalopods.

**Visual Organs in Solen.**†—B. Sharp has been led to believe that *Solen ensis* and *S. vagina*, the common razor-shells, are possessed of visual organs, by observing that a number of these animals which were exposed in a large basin for sale in Naples retracted their siphons when his hand cast a shadow over them. Repeating the experiment at the Zoological Station, he became convinced that the retraction was due to the shadow, and not to a slight jar which might have been the cause.

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* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 1–63 (4 pls.).

† Proc. Acad. Nat. Sci. Philad., 1883, pp. 248–9.

Upon examining the siphon, he found as many as fifty-five blackish-brown lines or grooves between, and at the base of, the short tentacular processes of the external edge. When a vertical section of these pigmented grooves is made, the cells of which they are composed are found to be very different from the ordinary epithelial cells of the surrounding tissue. The pigment-cells are from one-third to one-half longer than the latter, and consist of three distinct parts. The upper ninth or tenth part of each cell is perfectly transparent, and is not at all affected by the colouring matter used in making the preparation; the second part is deeply pigmented and opaque, and forms about one-half the cell; while the remainder consists of a clear mass which takes a slight tinge when coloured. This portion contains a well-defined nucleus filled with granular matter, and is probably the most active part of the cell. These retinal cells, if so they may be called, resemble those of the very primitive eye of *Patella*. The value to the *Solen* of an organ which would enable it to detect the shadow of approaching objects as it lies imbedded in the sand, with the end of the siphon protruding, must be evident; and the structure of the cells described bears sufficient relation to those of the eyes in *Patella*, *Fissurella*, and *Haliotis*, to make it highly probable that they constitute true primitive visual organs.

## Arthropoda.

### α. Insecta.

**Respiratory Centre of Insects.***—According to Dönhoff, the respiratory centre in the bee is situated in the anterior ganglia, and therefore the respiratory movements are put an end to by decapitation. Dr. O. Langendorff, from his investigations, finds that in the bee, wasp, and other insects, the respiratory movements are not destroyed by removal of the head, especially when by *tearing*, and not *cutting* it off, a great loss of blood is avoided; the respiratory movements show the same increased rapidity with a high temperature, slowing with a low temperature in the headless insect as in the uninjured insect.

A number of experiments were also made upon *Libellula depressa* and other insects belonging to the Pseudoneuroptera, in which group the segmentation of the body is very marked in correspondence with their ancestral type; in these insects the respiratory centre is not merely not localized in the head, but each segment is a complete centre in itself, being capable of respiratory movements when entirely isolated. "A better example to illustrate the physiological metamerism of the insect body can hardly be imagined; each segment with its ganglion is a physiological unity!" The results of a great number of observations are fully stated in the paper, and several diagrams are given of tracings obtained of the respiratory movements.

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* Arch. f. Anat. u. Physiol., 1883, pp. 80–8.

**Chordotonal Sense-organs and the Hearing of Insects.***—In a long and elaborate account of this subject, including numerous fresh observations, Prof. V. Graber describes under the above new designation the rod-like terminal secretory structures of the nerves of certain parts (chiefly legs or wings) of insects. The general type of rod is distinguished as *Scolopal*, or pencil-like, being pointed at the proximal end; this form is always hollow, and its walls are extraordinarily refractive. In general, an insect has but one form of these rods. Two subordinate forms are distinguished: (*a*) *Mononematic* and (*β*) *amphinematic*, according as the distal end is, or is not, pointed like the proximal; in the mononematic the distal end runs out into a slender filament. Mononematic rods may be either (*a*) *conocephalic*, with conical heads (larva of *Tabanus*, of *Tortrix* sp., Orthoptera and some *Formicidæ*); (*b*) *Apiocephalic* (a Phryganid-larva), head blunter; (*c*) *Conacocephalic*, truncate-conically headed (*Dytiscus*, some *Chironomus* larvæ, &c.); (*d*) *Cylindrocephalic*, head of equal diameter throughout (a saw-fly larva).

The amphinematic form of rod occurs in *Corethra*, larva of *Syrphus*, *Pediculidæ*. The fine distal process is to be regarded as the termination of the head of the rod, and not as a prolongation of the nerve-fibre. An essential difference between the amphinematic and mononematic rod is that, in the former, the nervous axial filament is firmly fixed or stretched within the cavity of the rod, while in the latter its distal end lies loose in the liquid which this cavity contains.

In the "scolopophors," or tubular end-organs of the chordotonal nerves, the "chord" of the rod is a prolongation of an axial process of the basal ganglion-cell. The usually compound masses of these organs vary greatly in the number of units contained in them; from occurring singly in *Tabanus* most *Chironomi*, they may number upwards of 100 (tympanal organ of *Acrididæ*) or 200 (some "poriferous" organs) in the same sense-organ; where they are few in number they are commonly very intimately connected, so that in some cases the contours of the different tubes are almost invisible (*Corethra*, *Ptychoptera*, *Tortrix*, *Syrphus*, &c.). In some genera (*Corethra*, &c.) the chordotonal organ of each segment is fastened to the integument by a special "ligament" consisting of a thin-walled tube in continuation with the sheath of the nerve, and filled with a homogeneous and slightly granular mass, and extending in a direction opposite to that of the chordotonal organ itself.

Of the general positions in which these organs occur, Graber states that the typical forms are always extended from one relatively immobile point of the integument to another; e. g. any one of the organs is wholly contained in one segment, and never invades the bands connecting the segments; they also show a tendency to have as great a length as the available space will admit of, and to maintain a relatively superficial position. They are as widely distributed among insects as the optic and tactile organs, in proof of which tables are given, deduced from observations (chiefly by Graber) made on upwards of sixty genera belonging to all the orders. These tables show further that their most usual seat is the hind-wings or halteres, the next the fore-wings; the legs are more often thus employed in the lower orders (*Hemiptera*, *Neuroptera*, and *Orthoptera*) than the wings.

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* Arch. f. Mikr. Anat., xx. (1882) pp. 506–640 (6 pls.).

As regards their phylogeny, Prof. Graber considers the serially arranged organs to have been derived from an original dispersed condition, and the simplest scolopoferous forms from nerve-endings devoid of rods.

The physiological division of Prof. Graber's work* leads up to the conclusion that the function of these organs is probably auditory. Sounding a loud note on a violin not far from a specimen of *Blatta germanica* engaged in walking across the floor, is followed by the immediate cessation of the movement; this may be repeated several times with a like result if the intervals between the notes are not too short. With specimens placed in a wide glass vessel the same thing occurs; a *Blatta* deprived of its eyes, and suspended by one leg and allowed to become quite motionless, manifested great excitement, jerking itself upwards, on a loud note being sounded on a violin at about a metre's distance. *Coccinella* behaves similarly, but in a less striking manner. Of water-insects, Graber finds that *Corixa* darts wildly about when the edge of the glass side of the aquarium is tapped with a glass rod; further experiments show that mere mechanical vibration is not the cause of the movement, but that it is due to pure sound. Important evidence was obtained as to the *quality* of sound audible to these insects; for neither did a loud but deep toned hand-bell sounded outside the aquarium, nor the lower notes of a violin, produce much result, but the notes E to D, &c., on the latter instrument always increased in the most striking manner the number of water-bugs aroused. The water-beetle *Laccophilus* is most readily excited, and in great numbers; *Dytiscus marginalis* and *Nepa cinerea* also reacts strongly to loud sounds. On the other hand many aquatic larvæ, especially *Ephemeridæ*, exhibit no distinct perception of sound, though remarkably sensitive to mechanical agitation of the surrounding medium. Variations in the intensity of sound may be demonstrated to be perceptible to insects.

Facts such as the great manifest sensitiveness of many insects to the grasshopper's chirp, too great to be explained as due to tactile sensation, militate against the hypothesis that the sense involved is merely tactile. Comparison of the structure of the tympanal chordotonal organs with that of the vertebrate ear leaves it probable that the former have acoustic properties; in the Gryllidæ the tympanum and auditory meatus are both represented (the latter by tracheal tubes, the former by a peculiar enlargement of the trachea), the organ of Corti is of course represented by the scolopoferous and other chordotonal nerve-endings already described; they exhibit a considerable variety in the amount of their sympathy with the movements of the tympanic organs in the different cases.

The primitive forms of chordotonal organ appear to have the same function as the more highly evolved. It is a fair inference from the nature of the materials composing these organs in insects that they are capable of transmitting vibrations of a high degree of rapidity. To certain objections to the acoustic theory of the functions of these organs it is replied that experiments show that this function in insects is not exclusively owned by the brain and the head, but that the perception of auditory sensations has its seat also in part in the ventral ganglia.

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* Loc. cit., xxi. (1882) pp. 65–145.

A. B. Lee [*] has also examined these organs in a number of Dipteran larvæ. He finds that, as a rule, there is one compound (polyscolopic) and one simple (monoscolopic) organ in each segment; they are always arranged in a bilaterally symmetrical manner; the number of elements in the compound organ is generally 3, but may be 2, 4, or 5. In opposition to the received view that the nerve-endings are rod-like bodies, consisting of body, head, and point of apex, the apex ending in a chord and the body being traversed by an axial fibre which is the termination of the axial fibre of a ganglion, Lee finds that there is no "apex" to the body, and that the "chord" of Graber's paper is a complex, not a simple termination of a ganglion-cell, that the axial fibre does not belong to the chord, and that the whole rod is to be regarded as a capsular investment of a swollen nerve-ending, and not as the nerve-ending itself. The appearances of "apex" and "chord," so often seen, are produced by certain conditions of the tubular wall, termed by Lee "apical tube," which is continued beyond the ends of the rods, hence the chord is made up of an axial fibre and an apical tube; this is the case with all the auditory rods examined. The axial fibre ends in a hollow bulb at the distal end of the head of the rod in the larva of *Simulium*. The head of the rod consists of two segments in all examples which were studied, the proximal division having the form of a truncate cone, the distal that of a perfect cone; the alleged cylindrical and conacoid forms appear from experiments to be due to imperfect resolving power in the Microscope employed; or, in the case of the conacocephalic form, to a delicate membrane which bridges over and conceals the angle between the body and its shoulder. Lee comes to the conclusion that what Graber describes as distal prolongations of the heads, from which the ideas implied in amphinematic and mononematic are derived, have no real existence, but that the appearance is produced by the lumen of a tube prolonged forwards from all around the head, and attached distally.

**Number of Segments in the Head of Winged Insects.**[†]—The statements concerning the number of segments which form the head of insects are very conflicting; thus, while Burmeister only recognizes two, Strauss-Durckheim allows as many as seven. Dr. A. S. Packard, jun., from the study of the embryos of a great many types, considers that four segments are always to be found, the appendages corresponding to these being the antennæ, mandibles, first maxillæ,

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[*] Loc. cit., xxiii. (1883) pp. 133-9 (1 pl.).

[†] Amer. Natural., xvii. (1883) pp. 1134-8 (1 fig.).

second maxillæ (labium). The clypeus and labrum, however, remain to be accounted for, and probably represent the tergal portion of the antennary segment, the procephalic lobes forming its pleural portion; these latter become the epicranium of the adult; hence the head of an adult insect is chiefly made up of the first, or antennary segment. The so-called "occiput" is shown to be the tergal portion of the fourth or labial segment; it generally disappears in the adult, or becomes soldered to the epicranium, but remains in *Corydalus* (a Neuropterous insect) as the base of the head.

The remainder of the original segments are obsolete, and take no part in the formation of the epicranium in the adult.

**Protective Device employed by a Glaucopid Caterpillar.***—It is well known that many caterpillars, e. g. those of the Arctiidæ, interweave their prickly hairs with their cocoons, thus not only rendering the latter stronger and thicker, but also furnishing a kind of protection in those species in which the hairs have an urticating power. A novel and ingenious method of utilizing its hair for the protection of the chrysalis is that employed by the larva of *Eupomia Eagrus*, as described and figured by Dr. Fritz Müller. Around the slender twig to which it intends to fasten its chrysalis, the larva constructs from its hairs, before and behind itself, a series of whorls, about six in number, the hairs in each whorl being vertically and very densely fastened to the twig. The inside whorls are so fastened that they incline over the head and tail ends of the pupa. Between these two formidable rows of palisades the pupa rests safe from the attacks of any small and unwinged enemy.

**Formation of Honeycomb.**†—It is well known that the cells of honeycomb afford the largest possible space and the greatest strength with the least possible expenditure of material; but the subject has not been properly investigated in a scientific manner. The earlier researches of Maraldi and others at the commencement of the eighteenth century showed that each cell in the honeycomb of bees consisted of a six-sided column bounded in the middle layer of the comb by a three-sided pyramid, and that the sides of the cells in the deepest portion form with each other angles of 120°, and the mathematical relations of the angles and sides of the cells to one another were investigated. The actual way in which the bees form the cells has been closely observed by Dr. K. Müllenhoff.

A number of the insects, at least a dozen on each side, commence to form the comb, and they are so arranged as to be exactly opposite one another; by mutual pressure therefore the lump of wax which each bee carries in its jaws becomes pressed out to form a plate; each bee, however, avoids coming into contact with the bee in front, and therefore the middle lamella of the honeycomb gets to be formed out of as many pairs of parallel trapezes as there are bees on each side. In a similar way the whole process of building the honeycomb was observed, and the observation showed clearly that the wonderful complexity and mathematical accuracy of the whole structure was not in the least owing to the development of a high instinct in the bees, but simply to physical laws dependent upon the position assumed by the workers and to the shape of their body and the plasticity of the wax. The cells of the comb are in reality circular, and in those species of wasps and bees which form but a single cell remain circular; the prismatic shape of the cells of a complex honeycomb is simply owing to the mutual pressure of the adjacent cells and is strictly analogous to the formation of cylindrical prismatic soap-bubbles by mutual pressure.

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* Kosmos, xii. (1883) p. 449 (figs.). Cf. Amer. Natural., xvii. (1883) p. 1289.

† Pflüger's Arch. f. gesammt. Physiol., xxxii. (1883) pp. 589–618.

We remember to have seen this explanation before, though we cannot now fix the reference.

**Mouth-Organs of Rhynchota.***—O. Geise regards the flattened or more or less curved process of the clypeus of the Rhynchota as the homologue of the labrum of beetles; the jointed groove corresponds to the labium, the two separable setæ to the mandibles, and the two, only with difficulty separable, setæ to the maxillæ of biting insects. He next considers the structure which Savigny regarded as the ligula, but to which most authors have applied Burmeister's name of "Wanzenplatte"; he himself proposes to speak of it as the pharynx, and describes it as being endowed with great elasticity, and as acting as a pump, which is set in action by the contraction of muscles attached to the body-wall, whereby the space in the walls in which they are inserted is enlarged, and a vacuum thereby formed. The structure and relations of these parts are entered into in great detail, but a full abstract of the paper would be impossible without a republication of the figures to which constant reference is made. The essay should receive the careful study of students of the anatomy of insects.

**Development of Genital Organs of Insects.**†—A. Schneider is here reported as concluding that a muscular fibre from the heart serves as the point of origin of the genital organs of insects; this may be best demonstrated by the larva of *Coretha plumicornis*, where a fibre belonging to the *alæ cordis* gives off a branch which passes backwards and ends at the intestine; a little way from its origin this fibre swells out and becomes provided with a large number of nuclei; at a later stage these nuclei may be seen to belong to two sets differing in size; the largest are surrounded by a layer of protoplasm and become the independent cells of the "primitive ova."

In the viviparous *Cecidomyiæ* there are ova which, like those of other insects, segment and undergo further development; these are never found in the ovarian sacs. In the rest of the Diptera and in all other insects the primitive ova give rise to ovarian culs-de-sac. In the Culicidæ each primitive ovum gives rise to a sac in which only one definite egg is found.

When a primitive ovum is transformed into an ovarian sac, the nucleus divides, one half becomes much larger and goes to form the nucleus of the egg, while the smaller undergoes division and forms a kind of follicle; some of the small nuclei increase in size and become eggs, and in this way moniliform sacs are formed.

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* Arch. f. Naturg., xlix. (1883) pp. 315–73 (1 pl.).

† Arch. Zool. Expér. et Gén., i. (1883) p. xlvii.

**Genital Ducts of Insects.**[*]—J. A. Palmen has here a preliminary note of his investigations into the comparative anatomy of the efferent ducts of the sexual organs in insects.

He commenced with the Ephemeridæ which are, among insects, remarkable for having the ducts paired, and that not only in all the larval but also in the imaginal stages, and in both sexes. In the males the two vasa deferentia extend, independently of one another, as far as the ventral side of the ninth segment, where there are placed the appended copulatory organs; these the ducts traverse and open at their tip or at the side. These appendages may be either almost separate, or be more or less fused at their base; in only one species examined was there any transverse connection between the ducts. In younger larvæ the vasa deferentia are delicate cords along which are placed the sperm-producing glands; in older larvæ the sperm is collected into the cavity of these cords, the walls of which become enlarged, while the ducts have here the function of vesiculæ seminales; the distal portion of the cord remains narrow and acts as an ejaculatory duct.

In the female the two oviducts are also independent and open between the seventh and eighth segments; the fold in which the orifices are placed has the chitinous layer of the body continued into it, and this extends as far as the orifices of the oviducts. At first delicate, the ducts become enlarged as the ova pass into them, and an organ of uterine appearance is developed proximally, and a vagina distally. On the whole it would seem to be clear that the Ephemeridæ represent, so far as their sexual organs are concerned, a very primitive type of organization.

An examination of the structure and descriptions given of the structure of the male organ in several species of Orthoptera and Trichoptera seem to show that the unpaired ductus ejaculatorius of these insects is morphologically an invagination of the integument of the body. In the larvæ of *Corethra* the two testes are attached to the integument by two cords, and in *Chironomus* there is much the same arrangement. During metamorphosis certain parts of the hindermost abdominal segments are reduced and others increased in size; in consequence of this the points of insertion of the cords —that is of the orifices of the vasa deferentia—pass inwards, and this part of the integument becomes unpaired. In the Forficulinæ the azygous condition of the terminal portion of the male sexual ducts is due to the development of an internal transverse connection between the vasa deferentia, and the consequent reduction of one of the two terminal portions, In this case, then, the unpaired ductus ejaculatorius and the vesicles arise from the primitive vasa deferentia and not from the integument.

In the Perlidæ, which stand close to the Ephemeridæ, we find that the oviducts open close to one another at the base of a median unpaired vagina. Chitin invades this last, and here we have an unpaired vagina which is, morphologically, a differentiated intersegmental fold, and, therefore, a derivate of the outer integument of the body. This process of differentiation in the Perlidæ may be regarded as typical of several groups of insects, complications notwithstanding.

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[*] Morphol. Jahrb., ix. (1883) pp. 169–76.

The generative organs of insects may, therefore, be regarded as formed from two elements which are morphologically distinct—the primitively internal paired structures (testes and vasa deferentia, ovaries and oviducts) and tegumentary structures. In the least differentiated groups (as in lower animal forms) the latter are only represented by the genital orifices, and, consequently, the whole apparatus is paired. The paired parts may become secondarily unpaired in four different ways—there may be the invagination of a common tegumentary portion, or the internal ducts may anastomose and fuse proximally to their origin, or these two processes may take effect together, or, finally, one of the symmetrical parts may become superfluous and reduced.

**Thoracic Musculature of Insects.***—C. Luks investigated the thoracic musculature of insects of every group, except, unfortunately, the Thysanura and Collembola. He finds that the wing-muscles appear to have developed along two lines; in one, the indirect flying muscles were almost completely aborted, while in the other they were developed at the expense of the direct muscles. In close connection with the development and modification of these muscles is the extent of concentration of the rings of the thorax and the size of the wings. In the Orthoptera all the three segments of the thorax are freely movable on one another, while in the Coleoptera only the prothorax is so movable. In the Lepidoptera the prothorax loses its mobility, though retaining its distinctness, while in the Diptera and Hymenoptera the whole region is converted into a firm thoracic apparatus, to which, in the latter, the first abdominal segment also becomes applied. As Graber has shown, we observe that in insects which, by other points in their organization intimate that they are more highly developed, one pair of wings tends to become aborted, as is seen in the Coleoptera, Diptera, and even Lepidoptera where the hinder pair of wings often become united with and share in the movement of the anterior pair.

**Early Developmental Stages of Viviparous Aphides.**†—L. Will, after noticing the results of earlier observers, comes to his own observations on the development of the ova; to examine the ovaries a fresh individual was opened on the slide in a weak salt solution, or in iodized serum; acetic acid was occasionally added, but this is a reagent which must be used with caution. Water at about 70° C. was found the best killing agent. Sections were largely made, and these were coloured with borax-carmine and hæmatoxylin.

The common oviduct opens on the ventral surface and in the median line, a little in front of the anus; as is well known, the seminal vesicle and cement-glands which are present in the oviparous are wanting in the viviparous forms. Connected with the oviduct by special canals are a number of ovarian tubes, the walls of which terminate in a filamentous process, which enters into connection with the similar filaments of the neighbouring tubes.

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* Jenaisch. Zeitschr. f. Med. u. Naturwiss., xvi. (1883) pp. 529–52 (2 pls.).

† Arbeit. Zool. Zoot. Inst. Würzb., vi. (1883) pp. 217–58 (1 pl.).

The tubes are camerated internally, and this cameration is obvious from without owing to the contraction of the outer walls; the wall of the tubes is formed by a distinct unilaminate epithelial layer; like Brass, the author was unable to detect any *tunica propria*; in the region of the oviduct the epithelial is invested by a muscular layer. At the other end, the terminal chamber of a mature ovary consists of two closely connected parts; in the inner one there is a homogeneous mass of protoplasm and then a number of cellular elements which fill up the space between the central protoplasm and the investing epithelium; both in position and structure these cells present the same appearance and relations as the yolk-forming or nutrient cells of oviparous Aphides; the central protoplasmic mass which they surround may be spoken of as the rachis. Like the young egg, these cells are without a membrane.

In the lower portions of the ovarian duct the flattened are replaced by cylindrical epithelial cells, and here large cells, which are young ova, are to be detected; the resemblances between these and the ova of oviparous forms is insisted on; we may indeed sum up the matter in saying the egg is attached to the central rachis by a stalk. The characters of the ova in succeeding chambers are pointed out, and attention is given to the fact that every two chambers are separated by a layer of cells formed by a thickening of the epithelium, and that there is in the centre only space sufficient for the passage of the connecting cord.

The function of the ovarian stalk is discussed, and the result is come to that thè ova grow by their own power of assimilation as well as in consequence of the assimilative power of the stalked rudiments; it seems to be clear that there is a streaming of the protoplasm which passes from the young ova through their stalk into the rachis and then through the cord of connection to the egg; it follows from this that the stalked cells of the terminal chamber must be regarded as rudimentary ova; they are not as Ludwig thought, nutrient cells, but true "Eianlage."

The author next passes to an account of the formation of the blastoderm, and he finds that in the viviparous Aphides the germinal vesicle does not disappear, but is directly converted into the first cleavage-nucleus. The first two spheres are only incompletely separated from one another; after this, fissive processes take place with great rapidity, and there appear to be no stages of repose. While the earlier divisions are being effected the egg increases greatly in size, and gradually becomes altered in form, exchanging its spherical for an elongated appearance.

The views and accounts of Brandt, Leuckart, and Brass are carefully reviewed.

**Chlorophyll in Aphides.***—L. Macchiati having noticed that certain Aphides when placed in a dark situation lost their colour in the same way that leaves do, investigated two species, *Siphonophora malvæ* and *S. rosæ*, with a view of ascertaining whether they contained chlorophyll; he discovered by applying the usual tests that chlorophyll was undoubtedly present; the objection that this substance is absorbed from plants by the insects and not elaborated in their own bodies, is met by the statement that it is also to be found in those species that live upon the coloured petals of flowers. The conclusion arrived at needs to be confirmed "by a more matured study," and M. Macchiati promises a fuller investigation of this interesting discovery.

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* Bull. Soc. Entomol. Ital., 1883, pp. 163-4.

### γ. Arachnida.

**Testis of Limulus.***—W. B. S. Benham describes the testis of *Limulus*. The organ consists of two lateral and a median network formed by ramifications and anastomoses of the vasa deferentia; on the walls of these ducts are situated the sperm-sacs, sometimes singly but more usually in groups; in the latter case the sacs communicate with each other and only one opens directly into the duct; the sacs contain groups of spermatozoa without tails, the latter being apparently developed within the ducts themselves; occasionally the sperm-sacs were situated at some distance from the ducts and no ductule could be traced from them; it is possible therefore that they are not formed as diverticula of the spermatic duct, but originate independently, and only acquire a secondary connection with it. The chief point that is dwelt upon in the paper is the branching and anastomoses of the spermatic duct; this fact lends strong support to Lankester's views concerning the close relationship between the Arachnida and *Limulus*; for in no crustacean is there any such network formed by the spermatic duct, whereas it is a constant character of the Arachnida.

**Polymorphism of Sarcoptidæ.**†—E. L. Trouessart and P. Mégnin have a note on the sexual and larval polymorphism of the plumicolous Sarcoptidæ. The species belong to the subfamily *Analgesinæ* which is divisible into the three groups of *Pterolycheæ*, *Analgeseæ*, and *Proctophyllodeæ*; in the two former the fecundated females, after their last ecdysis, have the abdomen entire and not lobed, but in the third the adult females have, at the end of the abdomen, two conical chitinous prolongations; a study of exotic forms shows that in nymphs and larvæ the abdomen is bifid. In one preparation, the male, even after the development of its generative organs, was seen inclosed in the transparent integument of the nymph with a forked abdomen; this, according to ordinarily received ideas, would lead us to think that the male emerged from the skin of a female.

The form, therefore, with a forked abdomen, is not sexual but larval, and we have here only another example of the law that female Sarcoptidæ retain more or less the form of the nymph, while the males take on a different appearance.

A still more remarkable polymorphism was observed in the males of a Pterolychid which may be distinguished as *Bdellorhynchus polymorphus*, which lives on such Anatidæ as *Erismatura*, *Querquedula*, and *Spatula*: while some of the males have the normal rostrum, others have the hooklets of their mandibles disproportionately elongated; in form these mandibles vary greatly; and indeed it is only the hinder part of the body which is normal and identical in these two sets. The genital organs are similar, but the copulatory cupules seem to be a little better developed in the normal males. Figures of the forms here noticed will be published.

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* Trans. Linn. Soc.—Zool., ii. (1883) pp. 363–6.

† Comptes Rendus, xcvii. (1883) pp. 1319–21.

### δ. Crustacea.

**Spermatogenesis of Podophthalmate Crustacea.***—G. Hermann finds that the testicular cells of podophthalmate Crustacea give rise to spermatoblasts, each of which becomes a spermatozoon. As in the Vertebrata, the formation of these commences by the appearance of a "cephalic nodule" in the spermatoblast, which becomes converted into a transparent vesicle, which gradually grows spherical. At the anterior pole of this vesicle there soon appears a kind of outgrowth of the wall which projects into the cavity; a short time afterwards a delicate rod appears at the opposite pole. These two outgrowths elongate, and, uniting, form a "central column" which extends from one to the other pole of the "cephalic vesicle." In the brachyurous Decapoda the vesicle generally becomes bell-shaped, the nuclear substance forms a kind of hemispherical cap, from the edges of which are emitted a number of filiform prolongations, varying in number and size. In this way the so-called radiate cell is produced. The body of the spermatoblastic cell seems to disappear very early.

In most of the *Macroura* the cephalic vesicle elongates, and a collar of opaque homogeneous substance is developed; this is at first circular, but soon becomes triangular, while the three angles are drawn out into filiform rigid prolongations. The fundamental phenomena appear to be constant, but the definitive form of the cephalic vesicle varies in various species. *Astacus fluviatilis* resembles the *Brachyura* by the possession of a number of prolongations.

It is to be noted that, in consequence of a kind of gradual condensation of their substance, the adult spermatozoa are smaller in size and often also simpler in structure than the transitory forms which appear in the course of their development.

It is possible that the great differences in the details of the structure of spermatozoa may throw some light on the zoological affinities of their possessors.

**American Isopoda.†**—O. Harger has a report on the Isopoda collected by the 'Blake'; though the number of species is small the collection was interesting for the large proportion of forms either new or not hitherto known from the American coast, while others have been only imperfectly described. *Cirolana impressa* and *Rocinela oculata* are the two new species.

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* Comptes Rendus, xcvii. (1883) pp. 958–61.

† Bull. Mus. Comp. Zool. Camb., xi. (1883) pp. 91–104 (4 pls.).

**New Host for Cirolana concharum Harger.***— S. Lockwood announces the discovery of this isopod in the interior of the edible crab, *Callinectes hastatus* Ordway. The crab was an adult female, and the parasites were crowded in the left side of the carapace. Incredible to say, there were twenty-three full-grown specimens, measuring 3/4 in. by about 1/4 in. each. The ovaries and the tissues on the left side were completely honeycombed. How long the animal could have lived, and what its real sufferance of pain was, are questions. But with these predaceous wolves, literally consuming its inner parts, it surely would soon succumb. It seemed to Mr. Lockwood that they must, when in the swimming larval state, have entered near the eye-stalks of the crab, which, with a large catch of others, was taken at the close of February in Raritan Bay, N.J. From the size of the parasites, it would seem that they had been in possession some three months. The determination of the isopods was due to Mr. O. Harger. The query how so large a number could have entered the same place, and at the same time, he thought was met by the supposition that the crab had found a nest of the larvæ, and was feeding on them, when a part of the batch entered the host, as conjectured above.

**Copepoda Entoparasitic on Compound Ascidians.**†—Prof. A. Della Valle finds three Copepoda in the compound ascidians of the Bay of Naples. The most abundant species are *Doroyxsis uncinata* and *Enterocola fulgens*; the first-named is found in the branchial sac, the second only in the stomach. For the third form is established a new genus, *Kossmecthrus*, distinguished by the form of the mouth-organs and by the dorsal position of the third pair of legs; the two legs of the fourth pair show a marked asymmetry; it occurs in the branchial sacs of the ascidians. Della Valle considers that *Enterocola* and the new genus should form types of two new families.

**Anatomy and Physiology of Sacculina.**‡—Y. Delage states that *Sacculina* is composed of two parts, one external and the other internal; the latter is made up of tubes and of a basilar membrane. This membrane forms a kind of flattened sac invested by a delicate chitinous layer, which is continued on to the tubes. Its walls are formed by a layer of large cells, which, in their deeper parts, separate into ramified filiform prolongations. The whole cavity of the sac is occupied by cavernous tissue, which is formed of cells converted into fibres; these ramify and anastomose abundantly.

The part which is external to the crab-host is enveloped in a sac which has been improperly called a mantle, and which serves to bound the incubatory pouch, and to protect the visceral mass. In its walls there is a close plexus of striated muscular and a layer of connective fibres; at the point of insertion of each of these latter there is a large nucleus—the nucleus of the cell which formed the fibre.

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* New Jersey St. Micr. Soc., meeting March 19, 1883. Cf. Science, ii. (1883) p. 664.

† Atti R. Accad. Lincei, Trans., vii. (1883) p. 180.

‡ Comptes Rendus, xcvii. (1883) pp. 961–4.

From the extremity of its sucking tubes as far as the superficial boundary of the body the *Sacculina* is traversed by a system of lacunæ in which there circulate the liquids taken in by the tubes and which forms a rudimentary digestive and incubatory apparatus.

Some of the spaces between the muscles of the visceral mass are occupied by sinuous tubes which are filled with ova, and are invested by the general endothelial layer. The ovaries open into the incubatory pouch, not far from the cloaca. There are two testicles, one on each side of the middle line, which open into the bottom of the pouch.

The nervous system is formed by a single ganglion which is situated in the visceral mass, near the cloacal end; this end, therefore, is the cephalic or upper one, and not the lower, as has been ordinarily supposed. This ganglion has the form of a four-rayed star, whence four chief nerves are given off; the two upper ramify in the muscular layer, giving off an important branch to the cloacal sphincter. The two lower pass to the visceral mass, some dividing into two branches, one of which innervates the muscular layer of the envelope, and the other the transverse muscular layers.

Two or three days after a *Sacculina* has set free its *Nauplius* it gives off some more ova; the chitinous layer which clothes the incubatory pouch undergoes ecdysis and passes out by the cloacal orifice. A new layer is formed, a number of ramified chitinous tubes escape from the oviduct, to the base of which they remain attached. The ova are now driven into and fill these tubes, which later on become detached and remain in the incubatory pouch till the ova are matured. The eggs are fertilized in the ovary.

In a second note on *Sacculina*,[*] M. Delage has some observations on an internal stage in its development; he finds that an early period is passed by the parasite within and not without the body of the crab; it is there found in a completely developed state, having its generative organs and its nervous system completely developed; and it is only when it grows larger that it changes its position. At the moment when it does so the orifice of its cloaca is closed and completely surmounted by a delicate chitinous membrane; a little later this breaks, and young Cyprids make their way to the periphery of the cloaca, where they become attached. All young Sacculinæ have Cyprids fixed to their cloaca, and these, therefore, as Fritz Müller supposed, play the part of complemental males.

In a third note[†] M. Delage considers the development of the *Cypris*; he finds that the young leave the incubatory pouch of the Sacculina under the *Nauplius* form. During the five ecdyses that take place in the next four days the two pairs of biramose appendages are lost, and the *Cypris* with its six pairs of limbs, its fixing organ, antennæ, and internal spherical mass of small cells, becomes developed. For three days or more the *Cypris* swims about freely; it then, either during the night or at some dark spot, attaches itself to young and very small crabs; this fixation is always effected by one of its antennæ, is always on a hair of the body, and is never on the ventral surface of the crab. After it has become fixed it undergoes a marvellous metamorphosis, becoming an elongated sac, in which little of the *Cypris* is left save the outer integument and the spherical mass of cells. A dart-shaped body is now developed at the antennary pole, which is driven into the tissues of the crab; to this dart the cellular mass is appended, and it, therefore, makes its way into the body of the host.

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[*] Tom. cit., pp. 1012–4.

[†] Tom. cit., pp. 1145–8.

The author believes he has shown that all that forms the adult *Sacculina* arises from the nucleus of the internal *Sacculina*, and that the basal membrane with its tubes arises from the sac which contained it. The wall of this sac represents the integument of the *Nauplius* or *Cypris*, and the nucleus the cellular mass contained in its body. We find, then, that the portion of the parasite interior to the crab represents the skin of the larva, the external portion a genital nucleus, which pierces its own investment and the integument of its host.

It is proposed to use in place of the term *Rhizocephala* that of *Centrogonida*, in reference to the dart-like organ of reproduction, and to form of them an order distinct from the Cirripedia.

On this communication Professor Lacaze-Duthiers made some remarks:[*] he insisted on the observations as demonstrating the advantage and necessity of experiment in zoology. As to the infectivity of young as compared with older crabs, he reminds us of the differences between young and old human beings in their receptivity of the poison of typhoid fever. The idea that the *Sacculina* fixes itself to the interior of the crab must be given up, and the animal not regarded as an ectoparasite, like a tick for example, but as first entoparasitic and then forming a true hernia, developed within and only passing outside the body to allow of the growth of some of its organs.

He concludes as follows: "If, in the eyes of some naturalists, zoology is a purely descriptive science, it ought in many cases to be experimental, so as to avoid the errors which are inseparable from a study made at a limited point of time in the existence of organisms. Our knowledge of development, which has been revealed to us by experiment, will alone allow us to have an exact appreciation of relations which are obscure and difficult of detection. It is for such an object that we must distinguish between a zoology which is purely descriptive and one which is experimental."

### Vermes.

**Classification of the Phyllodoceidæ.**[†]—G. Pruvot has especially devoted his attention to the nervous system of these annelids, and commences his note with an account of the arrangement found in *Phyllodoce laminosa*. One of the results of the investigation is the demonstration that the segment which carries the last tentacular cirrus does not differ essentially from the normal setigerous segments.

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[*] Comptes Rendus, xcvii. (1883) pp. 1148-51.

[†] Ibid, pp. 1224-6.

Although authors do not agree in their views as to the anterior appendages of the body, it is always possible to distinguish dorsal from ventral tentacular cirri: the latter cannot be taken note of in the formation of generic divisions, inasmuch as they insensibly change in form from below upwards; on the other hand the anterior dorsal cirri are subulate, and differ sharply in form from those which succeed them.

The Phyllodoceidæ, then, are best divided into two groups, one with five, the other with four antennæ; in each group there are forms in which the first three dorsal cirri are subulate, and others in which two only have that form. In the second division is ranked a new genus *Nothis*, in which the third segment is remarkable for having no dorsal cirrus.

**Anatomy of Polynoina.**[*]—A. G. Bourne has recently studied the anatomy of *Polynoe cava* Mont., and has succeeded in discovering the nephridia. Ehlers had previously described in a *P. pellucida* a series of contractile sacs opening externally by several ciliated mouths, both upon the dorsal and ventral side of the parapodium, which he regarded as the segmental organs; but these are, according to Haswell, in reality intestinal cæca; the true nephridia open upon the ventral papillæ which are developed upon all the segments with the exception of the last and the eight anterior; these ventral papillæ are known by the descriptions of Huxley and Grube, and are figured by many other authors, but they were believed to have some connection with the generative functions, owing to the fact that they were found to be filled with ova or spermatozoa at the time of sexual maturity; the generative products, however, are never found within the lumen of the nephridium, but only in the section of the body-cavity inclosed in the papilla; they probably make their way to the exterior by a rupturing here and there of the body-wall. The nephridia are short straight tubes, never convoluted though the wall may be variously folded and plaited; they open internally by a ciliated rosette; the lumen is enlarged into a vesicle at the base of the papilla; there are no muscles developed in the walls. Several other anatomical details are given in the memoir; the elytra are shown to be connected with the "dorsal surface of the somite proper," and not with the parapodium; in *P. areolata*, as in *Sigalion*, rudiments of notopodial cirri may co-exist with the elytra, thus disproving any homology. No blood enters the elytra, but they contain a nervous network ending in small papillæ, which are no doubt tactile.

**Spadella Marioni.**[†]—P. Gourret has a further note[‡] on this new Chætognath, in which he gives some account of its body-cavity and generative apparatus. On each side of the pharynx there is a glandular organ which opens by a short canal to the exterior; its swollen ventral portion is lined by cylindrical or conical cells, the contents of which are sometimes found to be small polygonal bodies; anatomically, it is perhaps analogous to the segmental organs found by Claparède in the anterior somites of tubicolous annelids. The various orifices of communication between the oviduct and the female gland, which Grassi has described in other Chætognaths, do not appear to be present in this form. The products also escape to the exterior by a ventral, and not by lateral orifices.

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[*] Trans. Linn. Soc.—Zool., ii. (1883) pp. 347–56 (3 pls.).

[†] Comptes Rendus, xcvii. (1883) pp. 1017–9.

[‡] Cf. this Journal, iii. (1883) p. 843.

The male gland has the nucleus of its epithelial cells very distinct; outside the epithelial there is a structureless layer, and beyond this are longitudinal muscular fibres. Some of the epithelial cells of the efferent duct are cylindrical, small, and nucleated, while others, which have no nucleus and are larger and more highly refractive, appear to be glandular in function.

**New Forms of Thalassema.***—K. Lampert describes as new *Thalassema formulosum*, *caudex*, *sorbillans*, and *vegrande*. He separates the species of the genus into two groups, according as the longitudinal layer of muscles is or is not separated into bundles. The next point of distinction is to be found in the number of the segmental organs, which, as is well known, is not constant in this genus, some species in each division having two, and some three pairs; this, however, is not an invariable character as in some examples only one pair are developed; nor can the distinction be of much aid to the systematic zoologist, inasmuch as the condition of the organs varies much with the maturity of the genital products, for which these glands act as efferent ducts.

**Spermatogenesis in the Nemertinea.**†—A. Sabatier believes that the difficulties in the way of observation of the various stages in spermatogenesis are the cause of the different accounts given by various observers, equally well skilled. Many of these difficulties are avoided by the study of the small *Tetrastemma flavida*, which under the compressorium becomes so transparent that it is possible to study what is going on in its tissues and organs, even with the aid of high powers; no previous preparation, nor any reagents are necessary for the examination of its germinal sacs or pouches, which, moreover, are well adapted for the purpose, inasmuch as they are not all at the same stage in development.

The spermatic sacs of a young *Tetrastemma* have a pyriform shape, and later on become oval, owing to the pressure exerted on them by the adjoining organs; they are placed between the internal muscular layer and the cæcal diverticula of the intestine, and are formed by a special membrane which is attached by short tubes to the body-wall; and these open to the exterior by lateral pores. These sacs may be seen to be filled with a finely striated substance, made up of bundles set along various axes; these bundles vary greatly in size; they are fusiform in shape; the median portion forms a zone of varying width and has its contents more or less granular, while the two terminal cones are distinctly striated. If we compress the animal and force the contents out of the sac there escape bundles which are either compact, or, when more mature, are broken up into an innumerable quantity of spermatozoa. The head of the spermatozoon is cylindrical and highly refractive, the tail very fine and very delicate. This is what is seen in a mature sperm-sac.

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* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 334–42.

† Mém. Acad. Sci. Montpellier, x. (1882) pp. 385–400 (3 pls.).

In an immature one we find a very different arrangement: a young sac is small, and has finely granular colourless contents; the protoplasm is homogeneous. In other small sacs we may find at the centre of the protoplasm a transparent sphere, which clearly represents a nucleus. In fact, at this stage the contents of a male sac look exactly like those of the female. The surface of the protoplasm next becomes covered with bosses formed by grooves; soon several separate protoplasmic spheres become apparent, while the central mass is, of course, diminished in size; the spheres vary greatly in size; during this process of segmentation the nucleus remains intact. In other cases the protoplasm of the cell is seen to be broken up by the formation within it of clefts and spaces; but, as in the other, the result is the disintegration of the primitive mass, the superficial becoming distinct from the central portion. Yet in other cases, and especially in the autumn, cells in which no nucleus was apparent were observed to develope a stellate space within themselves; here no central protoplasmic mass was left. The nucleus, then, does not appear to be essential to spermatogenesis, and it is the peripheral and not the central portion of the cell that becomes converted into spermatozoa.

If we now fix our attention on the peripheral bodies, we find that in each there arise endogenously a number of large-sized granules, while at the same time the protoplasm of the spherule elongates, becomes fusiform and transversely striated. The filaments which correspond to the striæ become more and more independent, the intermediate zone atrophies, and the filaments take on the definite form of the spermatozoa.

To sum up: The seminal sac of the Nemertinea forms *spermatospores*, or male ovules, composed of a mass of finely granular protoplasm, in which a nucleus may or may not be developed. The central portion tends to atrophy, while the peripheral takes on the form of plates or spheres which become attached to the inner wall of the sac. The central portion is the *protoblastophor*, the peripheral spherules the *protospermoblasts*. From each of these we get *deutoblastophors*, and *deutospermoblasts* which become spermatozoa.

**Development of Trematoda.**[*]—H. Schauinsland, after an elaborate account of the views of his predecessors in this field of inquiry, gives the results of his own observations on eight species of *Distomum*, and on *Aspidogaster conchicola*. His general results may be thus summed up: The Trematode ovum is made up of the true egg-cell and of the yolk, which at first arises, more or less, from large, rounded, nucleated cells; the egg-shell is formed by a highly coloured chitinous membrane, in which a long and a transverse axis can be generally detected; at one end there is nearly always an operculum, and that end is also that of the head. Cleavage is complete though irregular, being of course more or less dependent on the amount of yolk; the result is a solid mass of cells, which in time absorbs the whole of the yolk;

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[*] Jenaisch. Zeitschr. f. Med. u. Naturwiss., xvi. (1883) pp. 464–527 (3 pls.).

before this is effected one cell at the upper pole becomes constricted off, and gives rise to the "calotte-shaped" cells. In all the species examined there was found an investing membrane; at the periphery of the homogeneous cell-aggregate there is differentiated a layer of flattened cells, from which in *D. tereticolle* arises a structureless cuticle with eight plates beset with chitinous setæ; in all the other forms examined there is a ciliated membrane, in which it is not possible to demonstrate the presence of separate cells. The solid endoblast lying within the flattened ectoblastic cells is at first made up of similar cells, but in the course of development some of them become flattened out and form a kind of epithelial lining to the ectoblast; others, at the cephalic end, become fashioned into an enteron, the lumen of which is formed by the gradual degeneration of the inclosed cells. The great mass of the endoblast remains, however, unaltered, and gives rise to germinal cells.

Some young forms are provided with vessels in which ciliated infundibula are to be made out at certain points; in *Distomum cygnoides* and *D. tereticolle* these appear to be connected with the enteron.

The investing membrane is regarded by the author as a formation of the ectoblast which is developed in two successive layers: first there appear cells which may be called ectoblasts of the first order; these are replaced by the ectoblastic cells of the second order—the permanent embryonic ectoderm. It may be as well to remind the reader that Van Beneden has noted the same phenomenon in the Tæniadæ.

Further investigations are required to answer the question as to whether the muscles are truly of epithelial origin, or whether they have a mesenchymatous character; and the first point to be settled is the relation of the young stages of Trematodes to the Enterocœlia.

The author does not share the opinion of Leuckart as to the mesodermal character of the germinal cells; it is perhaps best to regard them as cleavage-elements which have not been used up, and which, being such, do not require any further fertilization. The germinal cells found in the first set of *Rédiæ* may similarly be looked upon as cleavage elements which have remained over from the first generation.

The resemblances between the developmental histories of the Trematoda and of *Malacobdella* are perhaps superficial. There is, again, a close resemblance between the Trematodes and the Mesozoa, and the only difference between the embryos of *Rhopolura* and of *Distomum* is that the former remains at a lower grade of development. The existence of the former in a highly nutrient fluid makes the development of any other organs than those of reproduction altogether superfluous: the organs which are developed in the Trematoda are such as are necessary to enable it to find a new and suitable host. The Distomidæ and the Orthonectidæ are therefore, in all probability, closely allied, though the direct origin of the former group is a more difficult question.

There are many very striking and important resemblances in the developmental history of the Tæniadæ and the Trematoda:

both are formed from two distinctly separated cell-layers; in the outer there appear chitinous hooks or setigerous plates or a large number of cilia. The chitinogenous layer and the investing membrane are formed in very much the same way.

Striking as the resemblances are, it is not impossible that it is merely accidental, and that the outer cell-layer of the Tænioid embryo is not comparable to the ectoderm of the young Trematode, but only to the underlying layer of epithelial cells. Further investigations on tæniæ are necessary to the resolution of this problem; if it should be shown that they do lose their ectoderm we should have, in these two groups, the only known examples of the complete loss of a germinal layer, inasmuch as Kleinenberg's observations on a similar phenomenon in *Hydra* appear to stand in want of revision.

**Simondsia paradoxa.**[*]—This remarkable parasite was briefly described by Dr. Cobbold in his 'Entozoa,' from some specimens discovered by Professor Simonds in the stomach of a German hog that had died in the Zoological Society's Gardens. The drawings and specimens were temporarily lost, but, having been fortunately recovered, Dr. Cobbold has been enabled to add considerably to his former description of the parasite. The most striking feature in the organization of the worm is a large rosette-shaped organ which represents a prolapsed uterus entirely comparable to the prolapsed uterus of *Sphærularia bombi*. The male, which is slightly smaller than the female, presents no specially interesting points of structure. In the female all the ovarian tubules and the uterine branches are contained within the rosette, but the position of the external opening could not be made out with certainty, though it is apparently situated at the base of the rosette in the ventral line. Each female is inclosed in a single cyst, the head alone projecting; the interior of the cyst shows a perfect cast of the rosette-shaped organ; the males are free.

**Monograph of the Melicertidæ.**[†]—L. Joliet finds that of all rotifers the Melicertidæ are those which are best adapted for the investigation of the processes of development, inasmuch as after the eggs are laid they are protected by the tube, and eggs are laid every day, and development is completed in three days.

To the three species, *M. ringens*, *M. pilula* Collins, and *M. tyro* Hudson, the author adds a fourth, *M. pedunculata*, which most nearly resembles the first, but is distinguished from it by being not free in its tube, but attached to it by a seta which is fixed to the end of its tail; the new species would seem to be rare, having as yet been found only at Nogent-la-Phaye, near Chartres. The pond in which it was found was for several years preceding the last two completely dried up; the so-called winter eggs are not formed in the winter only, but throughout the season of activity.

After a description of the general form, Joliet deals with the digestive tract, the mastax of which is incapable of such protrusion as is seen in *Notommata;* the author is of opinion that this capacity for protrusion shows that the organ in question is analogous to the armed proboscis of an annelid, and he adds, "nous donnons le nom d'œsophage à la portion suivante du tube digestif," but this is a procedure long since adopted by at least English writers on the anatomy of rotifers. The excretory apparatus is described as being very similar to that of *Lacinularia socialis.* The contractile vesicle found in most rotifers is absent, and its function seems to be taken on by the spacious cloaca. After some notes on the nervous system, the author passes to the processes of reproduction, to which the largest part of the essay is devoted.

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[*] Trans. Linn. Soc.—Zool., ii. (1883) pp. 357-61 (1 pl.).

[†] Arch. Zool. Expér. et Gén., i. (1883) pp. 131-224 (3 pls.).

His more important conclusions may be thus summed up:—

1. There is no difference in the position of the nervous system and tactile organs of the Melicertidæ and other rotifers. As in them, *Melicerta* has the central nervous system dorsal, that is to say, on the surface which corresponds to the cloacal orifice, and the unpaired tactile organ. Like all rotifers, *Melicerta* has three tactile organs, an unpaired dorsal, and two lateral pairs.

2. The organ regarded by Huxley as the ganglion is a gland which is set apart for providing the mucus by means of which the elements of the protective tube are held together. The formation of this tube has been described in a satisfactory manner by Gosse, Bedwell, and Grube. The motile "languette" placed beneath the vibratile pit takes the part of the axis of a wheel.

3. In the Melicertidæ the females may be divided into those which lay male, those that lay summer female, and those that lay winter female eggs. Each appears to have its speciality.

4. All ova are equally fit for fecundation, but all are not fecundated.

5. The male resembles that of *Lacinularia socialis.* The spermatozoa are ribbon-shaped, have an undulatory movement, and an elongated head. In the body of the female they become immobile, and collect on the surface of the ovary.

6. Save that perhaps the fecundated egg expels the polar globules, there is no difference in the development of ova coming from a fecundated or a virgin female.

7. The theory of Cohn, according to which only fecundated females lay winter eggs, while the summer ova are developed parthenogenetically, is not in accordance with the facts.

8. There are reasons for believing that the female fecundated summer egg gives rise to one which lays winter eggs, while a non-fecundated summer egg will only develope into one which lays male or female summer eggs.

9. There is certainly a relation between the number of males existing at a given time, and the number of winter eggs existing at about the same time.

10. The winter ought rather to be called durable eggs, for they are destined to resist dryness as much as cold.

11. The winter have the same early history as the summer eggs,

and are, at the time they are laid, distinguishable only by their size and colour. They undergo segmentation in the same way. At a certain time, the embryo is encysted in a cellular membrane lying internally to the vitelline membrane. Later on this becomes chitinized and ornamented, while the outer vitelline membrane disappears.

12. As far as the closure of the blastopore the male egg has the same history as the female.

13. The summer egg, if not fecundated, does not give off polar globules.

14. When the egg is laid it divides into two unequal segments, which divide regularly and symmetically up to the 16th stage. After this the derivates of the small segment predominate and inclose the others. When the blastoderm is formed the embryo consists of—

*a.* An internal layer entirely derived from the last and largest segmentation-sphere; this forms the intestine.

*b.* An outer layer which forms the ectoderm and is in great part, probably altogether, derived from the smaller primitive segment, and from the first sphere detached from the large segment.

*c.* A median layer which, if it does not form a continuous layer, at least does form groups of cells which are arranged between the outer and inner layers; this is derived from the two median spheres of the large primitive segment, and probably serves to form the genital organs and muscles.

This arrangement is a striking example of the way in which the order of the succession of the layers corresponds to the order of segmentation, the sphere the furthest from the animal pole serving exclusively to form the intestine, the two median spheres the genital organs and muscles, and, lastly, the three lower clear spheres the ectoderm.

15. When the blastoderm has been formed the embryological phenomena take place in the following order: formation of the tail; appearance of the vibratile pit, of the short cilia that cover it; development of the ocular pigment, of the large cilia of the wheel-organ; formation of the buccal cavity and of the cloaca by the invagination of the ectoderm; appearance of the meconium, of the mastax, of the vibratile cilia. The larva then escapes, leads for some time a wandering life, and then settles down to construct its tube.

## Echinodermata.

**Histology of Echinodermata.***—In his second communication † O. Hamann commences with an account of the nervous system of *Holothuria polii*, and of the structure of the "feet" of this form. In each of the so-called pyramidal feet we find a strong nerve-cord placed in the connective tissue, and composed of epithelial supporting cells, between the processes of which run the nerve-fibrils; below the apical disk they form a plate, and here the processes of the epithelial sensory cells pass into the layer of nerve-fibrils. Among the nerve-

* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 309–33 (3 pls.).

† See this Journal, iii (1883) p. 847.

fibrils ganglionic cells are scattered irregularly, and they are remarkable for the small quantity of protoplasm which surrounds the nucleus. While the pyramidal feet have not, the sucking feet have a sucking plate, the epidermis of which consists of elongated cells of palisade-like form; these pass into the circular ridge, the cells of which are much shorter and of two kinds; some are cylindrical and connected by fine fibrils with a layer which appears to be nervous, while others have stout processes, which pass perpendicularly through the nervous layer and become united with the subjacent connective tissue.

In each of the shield-shaped tentacles around the mouth we find that the stalk has a canal which gives off branches to each of the "capitula" which form the free end. The epithelial layer of these capitula is worth study; the cells are filamentous and give off processes which are of two kinds, some being stronger than the others and not forming a plexus. In longitudinal sections we see a layer underlying the epithelium, which is in parts finely granulated, and in parts striated; the epithelial supporting cells terminate beneath the fibrillar layer, while the separate fibrils of the epithelial sensory cells are continued into the nerve-cord of the epithelium, which again is a branch from the large nerve-trunk in the stalk of the tentacle.

The Cuvierian organs are next dealt with, and are described as tubular structures, beneath the ciliated epithelial layer of which is a peculiar striation; this consists of strongly projecting bands arranged circularly and parallel to one another, and have glandular cells, in rows, among them. Longitudinal and circular muscles are also to be observed. In the centre of ejected tubes there appears to be a canal, but this may be due to the breaking up of those structures, and fresh material must be examined before any certain conclusion as to its normal presence can be arrived at.

The circular nerve-cord of *Synapta* presents the following histological characters: the greater part of it is formed by circular fibrils, the nerve-fibres, among which cells are irregularly scattered; this nerve-layer proper is traversed by processes, which arise from the cells that form the superficial layer, and which, with their processes, may be regarded as supporting epithelial cells; they are homologous with the similarly named structures found in the epidermis of Asterids.

From the nerve-ring there are given off five radial nerves; these are set in the layer of connective substance, below them there is a vessel, then the circular, and then the radial muscles. The nerve-trunk is divided into two parts and probably also supported by a thin cord derived from the connective tissue. The radial nerve gives off fibrous bands, which supply the circular muscles, and others which pass to the periphery of the body and end in the tactile papillæ. These latter appear to be developed in consequence of the loss of the suckers or feet; they present the following structures: the epithelium is greatly thickened, and its cells are cylindrical and two or three times the length of an ordinary epithelial cell; nerve-fibres pass into them. In addition to these ordinary papillæ, there are others which inclose calcareous bodies, and especially those anchor-like structures which are so characteristic of the group; in these no nerve-fibres would seem to be found. Yet again, two kinds of glandular cells are developed in the integument. In addition to the ectodermal nerve-supply, there is an endodermal system of enteric nerves; the œsophageal portion supplies only the musculature of the œsophagus, but this is primitively endodermal in origin; the true ectodermal portion is found in the stomach and intestine, and its fibrils are richly supplied with ganglionic cells, and distinctly separated from the connective-tissue fibres.

The four regions of the digestive tract—œsophagus, stomach, intestine, and rectum—of *Synapta*, are both histologically and morphologically sharply separated from one another; and the whole tract is distinguished from that of the pedate Holothurians by the facts that the longitudinal layer of muscles lies externally and not internally to the circular, that there is a special gastric epithelium, and that the internal layer of connective tissue is strongly, while the outer layer is feebly developed.

The muscles of the body-wall appear to attain a remarkable strength in the Synaptidæ.

**Nervous System of Holothurians.***—R. Semon agrees with Johannes Müller in regarding the radial nerves as the primary, and the œsophageal ring as the secondary portion of the Holothurian nervous system; the histological characters of the former are more complicated, and they appear to be developed before the latter. In the young Synaptæ from which careful transverse sections were made, the radial nerves were seen to be completely developed and to have at either pole a relatively large swelling, but there was no indication of any commissure. The author disagrees with the ordinarily received doctrine that the nerves end in a point near the anus, for in that region he has been able to detect a considerable thickening in the nervous band, and he inclines to believe that a secondary anal commissure is developed; on the other hand, in the Aspido- and Dendrochirota there is certainly no such commissure, the appearance of which is really due to the elastic connective-tissue-fibres there developed. At either end of the digestive tract special sensory regions appear to be present, and Holothurians are notoriously sensitive at their mouth and anus, possibly to protect themselves from the parasites by which they are often infested.

After some observations on the topographical relations of the nervous system, the author passes to the histology; the difficulty of the investigation is even greater than in other groups of animals, owing to the small size of the elements, and our slight knowledge of the minute structure of the other organs. After the animal has been killed in boiled sea water, whereby it dies in an extended condition, and the elements have been isolated, it is as well to wash them several times in distilled water, as they have always a quantity of by-products associated with them. Staining reagents must be very carefully applied to the fresh tissues, as, unless they are very dilute, they will soon blacken the whole tissue. The author found his greatest difficulty in the absolute impossibility of completely separating the nervous from the surrounding tissues, and consequently, of being always certain as to the truly nervous character of the fibres and cells which he had under examination.

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* Jenaisch. Zeitschr. f. Med. u. Naturwiss., xvi. (1883) pp. 578–600 (2 pls.).

A transverse section of a radial nerve showed that the periphery was surrounded by cells, several layers thick, and that in the Aspidochirotæ, there were distinct aggregations of cells right and left of the middle line; these bands were not seen in the Dendrochirotæ or in the Synaptidæ. Internally one sees here and there cells, which in the Aspidochirotæ exhibit a certain arrangement, and which may be distinguished as internal and marginal; histologically, these cells have the same structure—a relatively large nucleus and a small quantity of protoplasm. The nervous band is provided with a membranous sheath which extends along its whole length and divides it into two halves; it is traversed by a system of transverse as well as of longitudinal fibres. The former may be certainly believed to enter into connection with the nerve-cells, but the relations, and indeed the essential nature, of the latter require further investigation.

Some remarks are made on the sensory organs, but no close examination has yet been made of the structures at the base of the tentacles of *Synapta*, which Müller regarded as eye-spots, or the auditory organ of Baur. The author has discovered at the end of the ambulacral pedicels and of the tentacles, plates which appear to have a fine tactile sensibility.

**Vascular System of Echinoderms.***—In No. VI. of his 'Notes on Echinoderm Morphology,' P. H. Carpenter discusses the recent utterances of various French anatomists on the anatomical relations of the vascular system.

Attention is first directed to the researches of Koehler, who finds, in addition to the one vascular ring round the mouth of an *Echinus* which has been acknowledged by Hoffmann and by Perrier, another oval ring which can be injected by inserting the cannula into the lower end of the "heart" or "ovoid gland" through the intermediation of a vessel which lies beside but is quite distinct from the water-tube. The injection will pass also into ramifications within the Polian vesicles, and, if pressure be used, into these organs, while the water-tube and radial vessels will also be injected. In Spatangids either of the two oral rings may be injected from the corresponding radial vessel, and each ring sends branches into the ambulacra. "This," Mr. Carpenter says, "leads to the suspicion that each radial vessel of an *Echinus* communicates directly with a corresponding vascular ring, just as was described by Teuscher, and that the water-vascular and blood-vascular systems are distinct, at any rate in the peristome and ambulacra." And it is further pointed out that Koehler's results would have had a still higher value if they had been more fully compared with the results of other anatomists, who have, in Asterids, Ophiurids, and Crinoids, already described independent blood-vascular and water-vascular systems.

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* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 597-616.

Koehler's studies give evidence of the connection between the "heart" and the blood-vascular system, which, while affirmed by Ludwig, Carpenter, and others, has been denied by Perrier and Apostolides. The organ in question is described as "a reticulum of connective tissue, supporting cellular elements that undergo a peculiar degeneration, the final result of which is the formation of numerous pigment-masses;" it might, perhaps, be convenient to speak of this body as the "plexiform gland"; it is most certainly not a heart, and may probably have something to do with the production of the common brown pigment-bodies.

After noting and criticizing some of Koehler's statements as to the fusion of the two vascular systems and other points in the anatomy of Spatangids, Perrier's recent note on the organization of Crinoids is taken up, and it is pointed out that, for the investigation of certain anatomical points, *Antedon eschrichti* affords more satisfactory material than *A. rosacea.* The blindness of the vessels connected with the "ovoid gland" is apparent only, and is due to the study of single thin sections; on the whole, Mr. Carpenter agrees rather with Ludwig than with Perrier in his views on the vascular system; the latter, however, is the first continental naturalist who has supported publicly the Carpenters' doctrine of the nervous nature of the fibrillar envelope of the chambered organ.* Mr. Carpenter reports the presence of bipolar cells in the branches of the axial cord in *Pentacrinus*, *Bathycrinus*, and *A. eschrichti;* and, in the last-named he has found that there is in the disk a fibrillar plexus which forms an annular network around the lip. Extensions of this plexus are, in all probability, connected with the fibrils of the sub-epithelial band, which by many anatomists is regarded as the sole nervous apparatus of the Crinoidea.

## Cœlenterata.

**Nervous System of Porpita**†—After a short account of the literature of the nervous system in the Cœlenterata, H. W. Conn and H. G. Beyer give a sketch of the general anatomy of *Porpita* before describing in detail the nervous and sensory structures of the animal. The nervous system consists entirely of scattered ganglion-cells, generally tripolar, but frequently also bipolar and sometimes multipolar; the fibres may be traced for some distance, dividing and subdividing, until they are finally lost in the muscular layer; in some cases the processes of several ganglion-cells unite. Transverse sections show that these cells are invariably ectodermic, and never endodermic as is the case in certain other Cœlenterata; the nerve-cells are most abundant in those parts of the body, e.g. the velum, where the muscular system is well developed, and appear to be entirely absent from the nutritive zooids which are unprovided with muscles. There is no trace of any central nervous system: no nerve-ring exists such as has been demonstrated in Medusæ.

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* Cf. this Journal, iii. (1883) p. 661.

† Studies Biol. Laboratory Johns Hopkins University, ii. (1883) pp. 433–45 (1 pl.).

Round the edge of the velum are a number of organs believed to be sensory; each consists of a small "ectodermal pocket," containing a number of large cells which are of two kinds; those on the outside are more slender and less granular than those in the interior, with which, however, as well as with the ordinary ectodermic cells, they are connected by insensible gradations. No connection was observed between these and the ganglion-cells, and not a single ganglionic corpuscle could be detected among them. Seeing, however, that the ganglionic cells are only developed in connection with the muscles, it is not to be wondered at that they are absent from these marginal sense-organs.

When the animals are kept in an aquarium for some time, the marginal bodies rapidly degenerate, the cells becoming fused together and the whole organ presenting the appearance of a fused granular mass, which causes them to resemble glandular organs.

**Bermudan Medusæ.***—J. Walter Fewkes gives a list and some account of the free jelly-fishes found in Castle Harbour, Bermuda, in May and June 1882. Among them is the representative of a new genus, *Oceanopsis*, which differ from other Oceanidæ by possessing four otocysts, from the neighbourhood of each of which, on the bell margin, there arise small tentacular filaments. One specimen of *Rhizophysa filiformis* was observed to be more than three feet in length.

### Porifera.

**Alleged new Type of Sponge.**†—Under the name *Camaraphysema obscura* J. A. Ryder describes and figures (from a single dead specimen) a lobate mass, chiefly made up of chambers lined by nucleated columnar cells resting on a basement membrane. The chambers contained ova in different stages of development; no collar-cells, sponge-mesoderm, fibres, or spicules were observed. From these points it will be sufficiently evident that the author has been mistaken in assigning the organism to this group. He mentions eversible funnels as lying in the mouths of the superficial chambers, and possibly the *Bryozoa* would more fitly receive this form, which, however, to be properly determined, should be studied in the living state.

**Biology and Anatomy of Clione.**‡—The first question propounded by N. Nassonow is, "How does the sponge make its way into the hard calcareous structures, and how does it complete its destructive work?" To answer this question he cultivated young sponges on thin transparent calcareous lamellæ; the larvæ, after a free stage, settled on the plates, and soon a rosette-shaped mark appeared; the sponge gave off thin processes which passed into the substance of the plate, and followed the contour lines of the rosette; about a day after the sponge settled a rosette-shaped particle was taken out of the plate; the body of the sponge entered the depression thus formed, took the particles into, and then cast them out of its body. Towards the evening of the day of observation the rosette-shaped marking had totally disappeared, and its place was taken by a small pit; into this the sponge contracted the greater part of its body. Chemical as well as mechanical agencies appeared to be at work, but the demonstration of the presence of the acid was prevented by the strong alkaline reaction of the sea water. Contrary to the view of Hancock, Nassonow thinks that the spicules of the sponge take no part in the boring operation; indeed, the young sponge began before it had developed any skeletal structures, not to say before it had completely taken on the other characters of the adult.

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* Bull. Mus. Comp. Zool. Camb., xi. (1883) pp. 79–90 (1 pl.).

† Proc. U. S. National Mus., iii. (1881) pp. 269–70 (7 figs.).

‡ Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 295–308 (2 pls.).

The second question deals with the influence of the parasitic mode of life on the organization of the sponge; of these results the most striking is perhaps the fact that *Clione* appears to pass its eggs into the water where, and not, as in all other sponges, in the body of the animal, they become fertilized.

Some information is given as to the structural characters of this sponge, and the author states that the best sections were obtained from specimens which had been treated with osmic acid, and hardened in alcohol; good results were also obtained by colouring with hæmatoxylin; sections should, on account of the spicules, be mounted in glycerine. On account of the closeness with which the mesodermal cells are packed the sections must, as in *Aplysina* (Schulze) be very thin. These closely-packed cell-layers fill, in parts, the whole of the inner body-mass, and among them foreign bodies—either food-remnants or calcareous particles—were not unfrequently observed. Various forms of cells are to be noticed, but between them all there are a large number of intermediate stages.

**New Siliceous Sponges from the Congo.***—W. Marshall introduces his description of these new sponges from fresh water by some general observations on the relation of fluviatile to marine sponges. Every one agrees that the former are genetically derived from the latter, and most think that the origin was a monophyletic one. The three general resemblances which lead to this view are: (1) they are monactinellids; (2) they inhabit fresh water; (3) they exhibit an asexual as well as a sexual method of reproduction. The first two points appear to be of no importance, when we consider that three-fourths of the marine Silicispongiæ appear to be monactinellid; and as against the third we have Dybowski's observation that there are no gemmules in the *Lubomirskia* of Lake Baikal, and that a number of marine forms reproduce by gemmation; yet again, we must bear in mind that gemmules are not confined to sponges, witness only the analogous case of the Bryozoa. Gemmules, then, no more than stinging cells, are to be used as criteria of genetic affinities. A careful discussion of all the facts of the case leads to the conclusion that fresh-water sponges are most closely allied to the Renierinæ, but that they have been developed independently of one another in different regions of the earth's surface, and that their resemblances to one another are due to the similar conditions of their new and altered mode of life. Some of these modifications have been acquired (e. g. gemmules) and may be said to be of a positive character, while others are negative, and are due to the disappearance of some of the characters of their marine allies; such is the loss of colour, owing no doubt to the disappearance of the conditions for self-protection which called it into existence. The fresh-water sponges may form the group Potamospongiæ among the Renierinæ.

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* Jenaisch. Zeitschr. f. Med. u. Naturwiss., xvi. (1883) pp. 553–79 (1 pl.).

Three species of the new genus *Potamolepis* are described: *P. leubnitziæ*, *P. chartaria*, and *P. pechuëlii*; they have no resemblance to *Spongilla*, or indeed to any Renierine sponge. The last species calls to mind a *Farrea*, owing to the macroscopic structure of its skeleton, and the arrangement of its fibres. The differences appear to be due to their surroundings, for the currents of water in the rainy season being of great force, it is necessary for *Potamolepis* to develope structures which are not necessary to the *Spongilla* of stagnant or gently flowing water.

## Protozoa.

**Parasitic Infusoria.*** — *Trichomonas vaginalis* is described by G. Künstler as extremely protean in external form; it may develope pseudopodia over the general surface or localized at the posterior extremity; at the anterior end are four flagella united by their bases, from which point an undulating membrane extends to the posterior extremity of the body. At the base of the flagella also the mouth opens; the nucleus, which varies in form, lies at the side of the œsophagus; the general protoplasm has a vacuolated structure. In the intestine of a certain Chelonian occurs a parasite apparently allied to *Giardia agilis*. The body is divided into two regions: the anterior is the larger, is vacuolated, and invested by a loose plicated and embossed sheath; the base of the flagellum has almost the same diameter as the body, is very long, and is readily shown to be striated; it reproduces by buds from the anterior extremity. Other organisms are mentioned as parasites, but not described, from the same host. *Heteromita*—or *Boda* (*Bodo ?*)—*Lacertæ* is described as a new species from the *intestine of Lacerta viridis;* the mouth is surrounded by a circular cushion, the nucleus often has a very complicated structure, presenting much variation, the body is areolar; reproduction takes place by transverse fission. A pyriform Flagellate, with four long locomotor flagella, with a lobule at their base, leading into the œsophagus, and a longitudinal costa on the left side, also occurs here. A quadri-flagellate organism with a large posterior vacuole is described from *Hydrophilus*, also an *Amœba*, which is truly amœbiform only in the young state, afterwards it maintains a finger-like shape and produces pseudopodia only from the anterior region. *Flagellata* are also indicated from various insects, from *Toxopneustes* and the blood of *Cavia*, a *Nyctotherus* from *Oryctes* and a Planarian from *Solen*, but with no, or but the briefest descriptions.

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* Comptes Rendus, xcvii. (1883) pp. 755–7.

**New Infusoria.**—O. E. Imhof [*] states the discovery in the Lac du Bourget in Savoy of *Dinobryon cylindricum* n. sp.

A. C. Stokes (of Trenton, N. J.) also records [†] a *Vorticella*, which, on account of its peculiar and well-developed external investment, he has named *Vorticella vestita*.

"Body soft and plastic, broadly campanulate, widest at the anterior margin, constricted beneath peristome border and posteriorly rounded at its junction with the pedicle; when contracted, subspheroidal. The whole cuticular surface is covered by a conspicuous cellular coating which gives the superficial aspect a minutely reticulated appearance, and the external margin a finely crenated outline when seen in optical section. This investment is formed of a single layer of cells arranged in equatorial series, the upper and lower cell-walls being equidistant in each row throughout the whole length of the body. The cells themselves are as colourless as the animalcule and as transparent, their contents being invisible liquid usually containing many dark-bordered, actively moving granules. When the creature is in a weakened or dying condition the cell-contents are so increased in quantity that the cells become extended and bubble-like, the zooid then resembling a mass of froth.

The peristome border is but slightly everted. The vestibular bristle is well-developed and conspicuous. The contractile vesicle pulsates at intervals of twelve seconds. The nucleus is band-like, curved, and remarkably long, one arm extended across the body anteriorly for almost its entire width, then bending and curving for nearly an equal distance along the ventral side of the zooid.

The pedicle is from six to seven times the length of the body, and when retracted forms about seven coils which exhibit transverse striations or wrinkles, particularly noticeable as it is extending. The muscular thread is roughened at irregular intervals by clusters of minute rounded elevations. Body 1/500 in. in height."

W. Milne also records [‡] one new genus and four new species from brackish water: *Tetramitus gyrans* n. sp.; *Hexamita Kentii* n. sp.; *Longicilium flexicuneus* n. gen. and sp.; and *Tillina barbata* n. sp.

**Relationship of the Flagellata to Algæ and Infusoria.**[§]—G. Klebs proposes to limit the term Flagellata to the Euglenaceæ and Peranemeæ, which are again divided into the Euglenida, Astasieæ, Chloropeltida, and Scytomonadina Stein; and discusses their structure, vital phenomena, and systematic position. The treatise is divided into three sections: (1) monograph of the Euglenaceæ; (2) some Flagellata in the older sense of the term, belonging to the lower chlorophyllaceous algæ; and (3) the fresh-water Peridineæ.

The Euglenaceæ are made up of the genera *Euglena*, *Trachelomonas*, *Colacium*, *Ascoglena* (Stein's *Euglenida*), *Eutreptia*, *Phacus*, *Astasia*, *Rhabdomonas* (two species of Stein's Astasieæ), and *Menoidium*

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[*] Zool. Anzeig., vi. (1883) pp. 655–7.

[†] Amer. Mon. Micr. Journ., iv. (1883) p. 208.

[‡] Proc. Phil. Soc. Glasgow, xiv. (1883) pp. 32–6 (1 pl.).

[§] Sep. repr. from Unters. Bot. Inst. Tübingen, i. (1883) 130 pp. (2 pls.). See Bot. Ztg., xli. (1883) p. 595.

Stein. The chlorophyllaceous are separated from the non-chlorophyllaceous hyaline Euglenaceæ. The author describes their general structure, system of vacuoles, contents, and investing structures, and then proceeds to their mode of division, resting condition, and the question of sexuality, as to which he obtained simply negative results, and the general biological phenomena of the green Euglenaceæ. He considers the colourless as direct descendants of the green forms, and as the link of relationship of the latter with other Flagellata. No systematic separation of the hyaline from the green forms is possible. Notwithstanding the numerous transitional forms between the different species of Euglenaceæ, the author establishes two groups with nine genera, the characters dependent on the delicate internal structure, the mode of movement, behaviour towards external influences, &c. The author then discusses the relationship of the Euglenaceæ to the Peranemeæ and Algæ. The Peranemeæ resemble the Euglenaceæ in essential points, but differ in the possession of a mouth-opening and special mouth-apparatus.

Among the Flagellata of Stein, the author regards, in addition to the Volvocineæ, *Chlorogonium euchlorum* Ehbg. as a typical Chlamydomonad, as also *Chlorangium stentorinum* from the family of Hydromorina. As is the case with the other Chlamydomonads, hyaline forms of both occur. A new classification of the unicellular Chlorophyceæ is proposed, associating under the name Protococcoideæ the groups Pleurococceæ, Chlorosphæraceæ, Tetrasporeæ, Chlamydomonadæ, Volvocineæ, Endosphæraceæ, Characieæ, and Hydrodictyeæ. The Endosphæraceæ, Tetrasporeæ, and Chlorosphæraceæ lead to the Siphoneæ, Ulvaceæ, and Confervaceæ.

The fresh-water forms of the Peridineæ, on the vegetable nature of which the author agrees with Leuckart, are treated of in detail, and the following are the general results at which the author has arrived.

The Euglenaceæ and Peranemeæ must be separated from the Ciliata and placed among the Infusoria, forming a separate division, the Flagellata, distinguished by a different mode of ciliation, and other differences in structure. The Volvocineæ, Chlamydomonadæ, and *Hydromorina* Stein remain partly among the Chlorophyceæ. From both the Ciliata and the Flagellata must also be separated the Peridineæ, termed by Claparède and Lachmann Çilioflagellata, and regarded by Bergh and Stein as a connecting link between these two groups; they form a well-marked family of Thallophytes.

Klebs' group of Flagellata remains, even if associated with the Infusoria, an intermediate group, connected on one hand, through the Cryptomonadæ, with the Algæ, on the other hand with the Vampyrellæ, rhizopod-like organisms, Noctilucæ, &c. Their general character connects them partly with the Protozoa, partly with the lower Thallophytes.

**Transformation of Flagellata into Alga-like Organisms.***— A paper intended to show some relations between animals and plants at their lowest degrees of development is contributed by M. Shmankevitch.

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* Mem. Novorossian Soc. Natural., vii. Cf. Nature, xxix. (1884) p. 274.

When the Flagellate *Anisonema acinus*—having a relatively high organization—is cultivated for many generations in a medium which is slowly modified, for instance in fresh water to which a certain amount of sea-salt is added, its structure is modified in proportion as the concentration of the solution of salt is increased. The individuals become less developed, their size diminishes, and the feeding-canal loses its former development. Numberless intermediate forms between *Anisonema acinus* and its new, less developed representatives, make their appearance, as well as between these and the still lower *Anisonema sulcatum*, which would thus be but a lower organized variety of the former. When the concentration of the medium in which the *Anisonema* lives is carried on side by side with a change of temperature of the medium, the transformation goes further on, and the lowest *Anisonema* are transformed on the one side into alga-like organisms, and in another direction into organisms which seem to belong to the category of fungi. The individuals not only become smaller, but they give rise also to a progeny long before reaching their full size. Under the influence of the sun's rays the uncoloured Flagellata acquire a new physiological function, and develope chlorophyll.

"We see thus," the author says, "the beginnings of two kingdoms, animal and vegetable, radiating from one common stem. We see the transformation of one of them into the other, not only in its morphological features, but also in its physiological functions, under the direct influence of physical and chemical agencies. The saline solutions, as compared with fresh water, diminish the size of the lower organisms, and at the same time they contribute towards the development of chlorophyll in the fresh-water algæ, thus giving them, so to say, a more vegetable character, together with an increased productiveness." And further: "Whilst descending from *Anisonema sulcatum* to a unicellular alga, we see the retrogressive development, a simplification of organization; we descend towards the plants containing chlorophyll. . . . While descending from the same *Anisonema* by another branch, we enter into the region of those lower organisms which, under the influence of another medium, do not develope chlorophyll, and, having no nutrition from the air, derive their food from the substratum; they might be described as parasitic Rhizopoda, and this the more, as from the fungoid form we can ascend, under some circumstances, not only towards the amœba-like uncoloured Flagellata, but also towards the moving monad. On the contrary, by reversing the physical agencies, we can arrive, from the unicellular alga, as well as from the fungoid form, to an uncoloured form having the structure of *Anisonema*." The researches of A. Giard, Cienkowsky, and Famintzin, and some observations by E. Ray Lankester, seem to be, in the author's opinion, in accordance with the above.

**Stein's 'Infusionsthiere.'***—The second half of Part III. of Dr. F. Ritter v. Stein's well-known work on the Infusoria, has just been published. It does not contain the expected characters of the genera and description of the species figured in the first part, which are still further deferred, but deals with the forms most of which are more usually known under the name of Cilio-flagellata.

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* Stein, F. Ritter v., 'Der Organismus der Infusionsthiere. III. Abth. II. Hälfte. Der Organismus der Arthrodelen Flagellaten.' fol., Leipzig, 1883, 30 pp. and 25 pls.

After a descriptive account of the course of his researches since the publication of the first half in 1878, the author gives a summary (in 23 pages) of the results at which he has arrived. The forms now treated of he considers to be a sub-order of the Flagellata, the simpler forms of Flagellates described by the first part forming the other sub-order. The latter he terms Monero-flagellata and the former Arthrodelo-flagellata. He objects to the name of Cilio-flagellata, as it supposes that the organisms besides a flagellum are provided with cilia, whilst *Prorocentrum* and *Noctiluca* are without such cilia. They all, however, have a distinctly articulated body, whence the designation Arthrodelo.

The division into five families is founded upon the modifications of the articulation, and the 30 genera upon the absence or presence of a secondary articulation of the body-covering as well as on their arrangement, number, form, and size. The following are the families and genera:—

Prorocentrinæ (*Prorocentrum*, *Dinopyxis*, and *Cenchridium*), Cladopyxidæ (*Cladopyxis*), Peridinidæ (*Gymnodinium*, *Hemidinium*, *Glenodinium*, *Clathrocysta*, *Heterocapsa*, *Amphidoma*, *Oxytoxum*, *Pyrgidium*, *Ceratocorys*, *Goniodoma*, *Gonyaulax*, *Blepharocysta*, *Podolampas*, *Diplopsalis*, *Peridinium*, and *Ceratium*).

Dinophysidæ (*Amphidinium*, *Phalacroma*, *Dinophysis*, *Amphisolenia*, *Citharistes*, *Histioneis*, and *Ornithocercus*).

Noctilucidæ (*Ptychodiscus*, *Pyrophacus*, and *Noctiluca*).

Being prevented by unfavourable weather from going to the sea, Dr. Stein bethought himself of trying the contents of the stomachs of marine animals preserved in spirit, and in this line of research he was completely successful, by far the most numerous and important of his discoveries being obtained from the stomachs of various Tunicates (*Ascidia*, *Salpa*, and *Cynthia*), Vermes (*Sabella*, *Serpula*, and *Sipunculus*), and Echinoderms (*Synapta*, *Ophiothrix*, '*Comatula*,' and *Actinometra*). Hundreds of individuals were obtained from one species of *Salpa*, and the author was occupied from November 1880 to the end of 1882 in the examination of the organisms he thus found.

A general description is given of the principal forms, with references to the 25 plates, which are also accompanied by brief "explanations." It was not found possible to engrave all these on copper as was done in the case of the plates of the preceding Parts, and 11 are accordingly lithographs.

It will be observed that Stein includes *Noctiluca* in his order of Arthrodelo-flagellata. His justification for this we propose to deal with later, but here may be mentioned that it is based on the discovery of the forms placed in the two genera *Ptychodiscus* and *Pyrophacus*, which on the one hand are closely related to *Noctiluca* while on the other they are unmistakably Arthrodelo-flagellates.

Among other novelties introduced by Stein are the following:—

The genus *Cenchridium* Ehrbg., hitherto placed with the Foraminifera and forming Williamson's *Entosolenia*, is referred to the Prorocentrinæ from its similarity to *Dinopyxis*, and particularly *D. compressa*. Examination of living individuals is desirable before this classification can be accepted.

*Dinopyxis compressa* has hitherto been, Stein thinks, erroneously classed as a diatom ( = *Pyxidicola compressa* Baily, *P. prisca* Ehrbg. ?).

The problematical organisms which Ehrenberg obtained from flints and described as species of *Xanthidium* (distinct from the true species of *Xanthidium*, which are unicellular algæ of fresh water) Stein places in the genus *Cladopyxis*—the sole genus of the Cladopyxidæ—on account of peculiarities of form which he considers show them to belong to the Flagellata. A species of *Cladopyxis* from the stomach of a *Salpa* is evidently very nearly allied to *X. ramosum* and *X. furcatum* Ehrbg.

**Cilio-Flagellata.***—G. Pouchet has made some observations on Cilio-flagellates, supplementing those of Bergh.†

A number of new forms are described, most of which the author hesitates to designate as new species on account of the very rudimentary state of our knowledge, ranging them as varieties in "specific groups." Of *Protoperidinium* two new species are described, of *Peridinium* one, *Glenodinium* three, and *Gymnodinium* one. No new light (the author says) is thrown on the mode of evolution and reproduction, and the facts observed in regard to the conjugation of *Ceratium*, the gemination of *Dinophysis*, and the segmentation of *Amphidinium* "do not seem to agree precisely with one another, and would suggest very great differences in the group which seems, however, to be so homogeneous and so natural."

Some species may present themselves in chains which break up to set at liberty the individuals which have arrived at their full development. The origin of these chains remains completely unknown. It seems scarcely probable that they are formed by epigenesis. They seem rather to result from the simultaneous development of a certain number of cells originally conjugated.

Other Cilio-flagellates (*Dinophysis*) are found in groups of two individuals, which are destined to separate later on; others (*Amphidinium*) divide and multiply after the manner of diatoms.

The mucous cyst, observed by Stein and Bergh, within which fission is said to take place, was never seen, but in some Cilio-flagellates provided with a test (*Peridinium divergens*) the body retracted within it was seen to give rise by fission to two new individuals.

The Cilio-flagellates appear to be directly allied to the *Noctilucæ*, which latter are perhaps directly derived from *P. divergens*. "Everything indicates the closest relationship between these organisms, and if the evolutionary chains pointed out here should come to be directly demonstrated, or if, on the other hand, the peridinian chains should arise, as there is every reason to believe, from cellular chains closely related to algæ (just as *Amphidinium* with the diatoms) then these peculiarities added to the organic complication of the genus *Polykrikos* furnished with an integument and nematocysts, would contribute to render still more indistinct the otherwise entirely artificial line between Plants and Animals."

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* Journ. Anat. et Physiol., xix. (1883) pp. 399–455 (12 figs. and 4 pls.).

† Cf. this Journal, ii. (1882) p. 351.

**New Choano-Flagellata.***—A. C. Stokes describes some new species of W. Saville Kent's order of Choano-Flagellata, viz. *Monosiga robusta*, *M. Woodiæ*, *M. longipes*, *Codosiga dichotoma*, *C. longipes*, *Salpingœca acuminata*.

**Anatomy of Sticholonche zanclea.**†—H. Fol gives a detailed account of the anatomy of this Protozoon, which was originally discovered and shortly described by R. Hertwig. He regards it as forming a special order of Rhizopods — Taxopoda. The main features of its organization are as follows:—The oval body is covered externally by a firm envelope, to which are attached a number of hollow spicules, probably chitinous, with a slight deposition of calcareous salts; these are arranged in radiately disposed groups; the membrane itself appears to be permeated by a system of fine tubules. The body is composed of a fine granular substance in which are imbedded a vast number of clear spherical globules; in the interior is a large "reniform body," covered with a closely set array of rods, and containing in its interior a spherical highly refracting body. There are no true pseudopodia, but a series of "arms," somewhat like the suckers of *Acinetæ*, attached in four longitudinal rows to the rods of the reniform body. Thus far the observations are mainly confirmatory of those of Hertwig. The most important addition to the anatomy of this protozoon is the description of a large mass situated on the concave surface of the reniform body. This mass shows two distinct forms, always seen in different individuals, (1) a number of small globules which pass gradually into the sarcode globules of the body, (2) a single large corpuscle increasing in size with the growth of the animal, and which, when it has arrived at complete maturity, is liberated in the form of an holotrichous Infusorian. This body was observed and figured by Hertwig in certain Radiolarians but erroneously described as a nucleus, and since the "nucleus" is inclosed within the central capsule in these Radiolarians, it seems to be proved that the latter cannot correspond to the reniform body of *Sticholonche*. The further development of this infusoriform body was watched, and it appeared finally to break up into a number of minute spores, the subsequent fate of which could not be traced. The hypothesis at once suggests itself that the two kinds of individuals, one with the mass of globules, the other with the infusoriform body, are of different sexes, but all attempts at fertilization failed. Nothing therefore can be said with certainty concerning the relations and functions of these different structures, though it is evident that the latter at any rate are connected with the reproductive process; if merely parasites their constant presence and in the same spot is inexplicable. A comparison with other Rhizopods affords no satisfactory explanation of the problematical infusoriform body, though it possibly corresponds to the gemmules arising within the central capsule by which many Radiolarians are propagated.

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* Amer. Mon. Micr. Journ., iv. (1883) pp. 204-8 (6 figs.).

† Mém. Instit. Nat. Genevois, xv. (1883) pp. 3-35 (2 pls.).

The following is M. Fol's diagnosis of this genus:—

"Pseudopodia in four rows. Nucleiform body curved in the form of a bean. Membranous envelope of intercrossed tubular fibres. Spines in the form of pins and sabres, arranged in divergent groups."

**Studies on the Foraminifera.***—G. Shacko has studied some Orbulinæ from Cape Verde, in which he noticed the large spheres which Moseley regarded as parasitic algæ, and Lankester as cell-nuclei; he is himself inclined to regard them as embryonic chambers, but he did not test them with acids. In some Orbulinæ from the miocene strata of Lapugy he found the shells closely covered by Globigerinæ, but he is not able to understand exactly what their relations to one another were.

A study of the embryos of *Peneroplis proteus* leads him to think that there must be here a very regular constriction of the protoplasm with the formation of nuclei, or else a very regular breaking-up of the whole of the sarcode, such as is seen in the central capsule of the Radiolaria.

The perforation of the shell of *Peneroplis* has also been studied, and the impression arrived at is that the upper layer of the shell was at first really perforated, and that later on this perforation disappeared, when the septal surfaces and their large tubes became firmer.

**Development of Stylorhynchus.**†—A. Schneider finds that *Stylorhynchus* passes through the greater number of its developmental stages, and often even acquires its adult structure in the interior of an epithelial cell of its host. The same epithelial cell contains several developing parasites. The young is at first similar to a coccidium; this coccidium buds off the segment which will answer to the deutomerite of the adult, then the protomerite, and finally the neck. The primitive body, therefore, minus the nucleus, corresponds to the fixation apparatus of the adult. The nucleus retains its original position till the formation of the protomerite, when it descends into the deutomerite; and the cavity of the rostrum corresponds to the position originally occupied by the nucleus.

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* Arch. f. Naturgesch., xlix. (1883) pp. 428-53 (2 pls.).

† Comptes Rendus, xcvii. (1883) p. 1151.

# BOTANY.

## A. GENERAL, including Embryology and Histology of the Phanerogamia.

**Relations of Protoplasm and Cell-wall in the Vegetable Cell.***—F. O. Bower considers that it has now been demonstrated with as much certainty as is possible, by the use of microchemical and staining reagents, that in certain cases, the number of which is now constantly being increased, there is a direct connection between the protoplasmic bodies on opposite sides of cell-walls, and that this connection is established by means of fine strings of protoplasm which, in the cases observed, run nearly transversely through the walls. The question remains whether this is the only mode of permeation of the cell-wall by protoplasm. The author cannot accept it as proved as yet that any further permeation of the cell-wall by protoplasm really exists, but he brings forward certain grounds for regarding such a permeation as possible or even probable, taking into account chiefly those phenomena observed in free cell-walls, in order thereby to avoid any confusion with connecting strings, such as those already proved to exist:—

1. The strings already observed vary greatly in thickness, from the well-marked to the undistinguishable; thus we have evidence of the existence of strings which would probably not have been recognized were it not for comparison with other examples. Further, it has been shown, in the author's paper on plasmolysis, that protoplasm may be drawn out into strings so fine as to defy definition, even by high powers of the Microscope; thus there can be no objection on the ground of the small size of the hypothetical strings or reticulum.

2. Those cases in which a perforation of cell-walls has been demonstrated are those very cases in which a most efficient physiological connection is required. There is no reason why a less obvious permeation should be denied where the requirements are less, but by no means absent.

3. There is *a priori* probability of some form of permeation of cell-wall by protoplasm, if Strasburger's account of the growth of cell-walls be correct.

4. A strong argument in favour of such general permeation of walls by protoplasm is found in the existence of important chemical changes in the substance of certain cell-walls at points at a considerable distance from the main protoplasmic body, e. g. formation of cuticular substance, wax, &c., which differ fundamentally from cellulose, are insoluble in water, and are apparently formed in the wall itself. The tendency of recent observations is to show more and more clearly how close the connection of protoplasm with the important chemical changes in the plant is; thus it appears probable that protoplasm is present in some form or other in the cell-wall.

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* Proc. Brit. Assoc. Adv. Sci., 1883, p. 581. Cf. this Journal, iii. (1883) pp. 225, 524, 677.

Reasons are also given for thinking that the exposure to air is not an important factor in the above changes. These and other considerations show that though this permeation of the wall cannot be accepted as proved as yet in any one case, still the subject deserves more close attention than it has yet received, while it may be expected that the application of new methods may produce definite results bearing on this very important question.

**Intercellular Connection of Protoplasts.**[*]—W. Hillhouse gives the results of a large number of observations to prove the intercellular connection of protoplasm. Out of twenty-two plants examined, these connections were only found in the cortical tissue of *Ilex Aquifolium* and *Æsculus hippocastanum*, the pulvinus of *Prunus laurocerasus*, and the winter bud pith of *Acer pseudoplatanus*; he, however, points out that these connections are easily broken in preparation, and that a single connection between a number of cells would be sufficient to produce a perfect unity of action. His conclusions are:—

1. That protoplasmic threads connecting neighbouring protoplasts are present in such widely different and diffused structures as sieve-tubes, cortical parenchyma, leaf-pulvinus, pith of resting leaf-bud, and endosperm of seeds.
2. That in the contraction of the protoplast in natural plasmolysis these threads would normally remain unbroken.
3. That they may serve to transmit impulses from one cell to another, acting in this way somewhat like a nervous system.
4. That besides the perforating threads, equally widely spread and much more numerous, are threads which attach the protoplast to the cell-wall, whether at the base of pits or otherwise, and that these threads are often opposite each other.
5. That the closing membrane separating two threads often shows differentiation, which suggests permeability, if not "sieve-perforation."
6. That in the contraction of the protoplast in natural plasmolysis these threads would naturally be unbroken.
7. That these threads may, when in extension, act upon the cell-wall and put it in a state of slight positive tension.
8. That the presence of minute perforations communicating from cavity to cavity of living cells would not, and when communicating with the intercellular spaces need not, be a hindrance to the turgidity of the cells.

**Polyembryony of Trifolium pratense.**[†]—B. Jönsson describes a case of polyembryony in the common red clover. He regards it as arising, not from the presence of several embryo-sacs, but from the formation of more than one ovum-cell in the embryo-sac.

**Mechanical Structure of Pollen-grains.**[‡]—J. Vesque states that pollen-grains shrink from evaporation of water; those of a spherical form sometimes assuming a convexo-concave shape. If the original form is maintained, this is effected by longitudinal ribs. The number of pores has no systematic value; the development of spines and other emergences depends on the law of the greatest economy of space. The pores are so arranged that at least one always comes into contact with the stigmatic fluid. When there is only one pore, this is a compensation to the abundant development of pollen as a protection against self-fertilization.

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[*] Proc. Brit. Assoc. Adv. Sci., 1883. Cf. Nature, xxix. (1883) p. 582. Cf. this Journal, iii. (1883) p. 524.

[†] Bot. Notiser, 1883, pp. 135–7. See Bot. Centralbl., xvi. (1883) p. 171.

[‡] Comptes Rendus, xcvi. (1883) pp. 1684–6.

**Fertilization of Philodendron.**[*]—E. Warming describes the phenomena connected with the fertilization of *Philodendron bipinnatifidum*, belonging to the Araceæ. The period of blossoming extends over from 34 to 36 hours; about 7 P.M. on the first day a great increase in temperature takes place in the staminodes and male flowers, to the extent of 18·5° C. excess over that of the surrounding air; no increase of temperature takes place in the female flowers; between 9 and 10 A.M. the next morning a second rise takes place to the extent of from 5° to 7°. About noon of the first day an aromatic odour is perceptible, and towards noon of the second day there is an abundant exudation of an aromatic sap. The anthers open between 4 and 5 P.M., and about 7 the blossoming is at an end. The author considers that fertilization is effected by pollen from the same spike, carried by small black bees, not by snails, as has been supposed.

**Fertilization of the Prickly Pear.**[†]—Dr. R. E. Kunzé sees in the irritable stamens of *Opuntia vulgaris*, a provision for securing cross fertilization by insect aid. In fair weather each flower opens on two successive days. Hive-bees, flies, and humble-bees were seen to visit the flowers for nectar, in obtaining which they grasp clusters of stamens, which, when released, fly up against the pistil, from which they slowly recede to their former position. Although the legs of the insects were covered with masses of pollen after visiting a flower, they were not seen to creep over the stigmas. The pollen-grains are therefore supposed to be thrown between the stigmas after the sudden movement of the stamens following the retreat of an insect. It is hardly necessary to add, however, that crossing is well effected by the insects in question, the motion of the stamens insuring a thorough dusting of their bodies with pollen.

**Annual Development of Bast.**[‡]—C. Hielscher has examined twenty-six different dicotyledonous and coniferous trees with respect to the amount of fresh bast formed each year. He finds that it does not consist of such well-marked regularly recurring zones as the wood in its annual rings. The primary bast always consists of both hard and soft bast; the secondary bast, formed every year, has usually the same composition, though in some cases, as *Alnus* and *Fagus*, after the second year soft bast only is developed. The amount of bast produced annually consists of three or more tangential rows of soft bast-cells.

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[*] Engler's Bot. Jahrb., iv. (1883) pp. 328–40. See Bot. Centralbl., xv. (1883) p. 372.

[†] Bull. Torrey Bot. Club, x. (1883) pp. 79–81. Cf. Science, ii. (1883) p. 381.

[‡] Abhandl. Naturf. Gesell. Halle, xvi. pp. 113–39.

Independently of the layers, probably functionless, which lie above the cork, the number of zones of active bast is only small. The increase amounts at most to 1/5, usually to not more than from 1/10 to 1/20 of the total increase of the wood.

In order to distinguish between hard and soft bast the author employs anilin sulphate, which stains yellow the elements of the hard bast only. The hard bast appears to be formed first out of the cambium. On each ring of wood, two zones of bast are often formed annually, but one only, or more than two, are not uncommon. In the older stems of many plants the formation of groups of sclerenchymatous cells in addition to bast-fibres is frequent.

**Lenticels and the mode of their replacement in some woody tissues.***—H. Klebahn adopts Stahl's classification of the lenticels of dicotyledons and conifers under two types, viz:—(1) those composed of loose cork-cells with denser intermediate striæ, and (2) those with closely packed cork-cells without intermediate striæ. The former kind occur in *Sophora*, *Robinia*, *Alnus*, *Betula*, *Cratægus*, *Sorbus*, *Prunus*, and *Æsculus*; the latter in *Gingko* (*Salisburia*), *Sambucus*, *Lonicera*, *Euonymus*, *Cornus*, *Salix*, *Myrica*, and *Ampelopsis*. In both cases he regards the function of the lenticels to be as organs of aeration, to promote both the interchange of gases and transpiration.

The author then investigates by what means this function is performed in those climbing shrubs which are destitute of lenticels, and finds, in all cases, in the medullary rays, a number of parallel intercellular spaces running in a radial direction through the wood, cambium, and cortex. They are in communication with the intercellular spaces of the wood on the one hand and of the primary cortex on the other hand, and form a very efficient system of aeration for the wood.

**Gum-cells of Cereals.**†—Johannsen objects to the term "gum-cells" (*Kleberzellen*), applied by Hartig to certain cells in the grains of cereals. On examining thin sections which had been preserved for years in alcohol, he found in these cells a very evident protoplasmic network or system of chambers, the contents of which, probably drops of oil, were soluble in alcohol. Sections of dry grains of wheat, rye, and barley examined in water show in these cells numerous round strongly refringent bodies of nearly uniform size, and larger drops, clearly of oil. Both are stained brown by osmic acid, but only slowly yellow by iodine-water. They consist of oil.

Separate portions of the protoplasmic network were also examined, the meshes of which were nearly as large as the smallest drops of oil. Sometimes they are also stained by osmic acid, and therefore contain oil. The sections were heated for a day or longer with absolute alcohol containing 2 per cent. of corrosive sublimate, when nothing but a protoplasmic network was always left behind, coloured by iodine or anilin-blue.

Since even the most soluble proteinaceous substances become insoluble on treatment with alcohol and corrosive sublimate, the author considers it probable that the "gum-cells" do not contain albuminoids, but drops of oil imbedded in a protoplasmic network, and proposes for them the preferable term "oil-cells" (*Fettzellen*).

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* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 113-21 (1 pl.).

† Meddel. Bot. Foren. Kjöbenhavn, 1883. See Bot. Centralbl., xv. (1883) p. 305.

**Nucleus in Amylaceous Wood-cells.**[*]—B. Schorler has investigated the structure of the nucleus in the starch-containing cells of a large number of trees and shrubs belonging to different natural orders. He finds a nucleus universally present in living cells, although of so delicate a nature that it is often not visible except by hardening and staining. Its form is originally spherical or ellipsoidal; but external forces subsequently bring about a great variety of changes. The size also varies very greatly; it is on the average larger in Coniferæ than in dicotyledons. The measurements are given of the nuclei in a great number of species, the length varying from 3 to 25·5 μ; the breadth from 1·5 to 18·5 μ; while some are nearly as broad as long, in others the length is ten times the breadth. The internal differences are but comparatively small, as shown by the different degrees in which pigments are taken up. One or more nucleoli may be present, and a nuclear membrane can usually be detected.

Even in mature wood-cells the nuclei are often not only in a living condition, but are even capable of division. The nucleus may remain unchanged so long as starch is still stored up in the cells. In the older rings of wood they may even retain their vitality for a period of eighty-six years (*Sorbus torminalis*), or even longer. When dead the nucleus does not necessarily disappear, it may become disorganized by a complete change in its internal structure, exhibited by its losing its granular character and becoming rigid, frequently in consequence of becoming permeated by resin. Such nuclei, of a dark brown colour, have been found in the 110th annual ring of the yew.

**Peculiar Stomata in Coniferæ.**[†]—K. Wilhelm describes a peculiar structure of the stomata in the leaves of *Abies pectinata*, the outermost cavity of the stoma containing, at all times of the year, a number of nearly black patches composed of a great quantity of minute granules. The particles are nearly insoluble in cold, but very soluble in hot alcohol, and are of the nature of wax, apparently identical with that which covers the surface of the leaves. Their purpose is apparently to hinder transpiration. This peculiar substance appears to be invariably present in the stomata of *Abies pectinata*, and in many other Abietineæ and Cupressineæ, but was not found in the yew.

**Root-hairs.**[‡]—F. Schwarz publishes an exhaustive account of the root-hairs of plants in their morphological and physiological relations. Although it is possible in certain cases for roots to absorb nourishment from the soil when destitute of root-hairs, yet the latter are unquestionably the most important organs for this purpose. The increase of surface brought about by root-hairs as compared with that of naked roots at from 5·5 to 18·7.

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[*] Jenaisch. Zeitschr. f. Naturw., xvi. (1883) pp. 329–57.

[†] Ber. Deutsch. Bot. Gesell., i. (1883) pp. 325–30.

[‡] Unters. Bot. Inst. Tübingen, i. (1883) pp. 135–88 (1 pl.). See Bot. Centralbl., xv. (1883) p. 337.

The root-hair has a constant tendency to grow in a downward vertical direction; when this is interfered with by any solid body, it grows along this body until it can again resume its original direction. A close attachment to the particles of soil is increased by the mucilaginous character of the outermost cell-wall. They are formed only at a certain distance from the apex of the root, in order not to interfere with the hydrotropic and geotropic movement of the latter. The external condition which affects more than any other the formation of root-hairs is the degree of moisture; too little and too much moisture are equally unfavourable. A retardation of growth from too much moisture goes along with a reduction of the amount of root-hairs; a retardation of growth from too little moisture causes a local increase of root-hairs, though the total quantity may be diminished.

The suppression of root-hairs in many water-plants is not due to the smaller supply of oxygen, but to other causes not altogether known at present; some water-plants form root-hairs abundantly when their roots penetrate into mud or soil.

Entire suppression of the root-hairs occurs in only comparatively few plants, not connected genetically, but related only in their mode of life. They are nearly or altogether purposeless in such as have a very abundant supply of water, as many bog- and water-plants, like *Butomus*, *Caltha*, *Euryale*, *Lemna*, *Nymphæa*, &c., and in those which, owing to their very small power of transpiration, require but very little water, as many Coniferæ, *Agave*, *Phœnix*, &c., from which they are altogether absent. They occur, however, in some succulent plants, as Crassulaceæ and Cactaceæ; in the bulbous and tuberous Liliaceæ they are present or absent according to their habit. Parasites usually have root-hairs when they also have the power of growing independently, as *Euphrasia* and *Melampyrum*; *Rhinanthus*, parasitic on the roots of grass, is destitute of them; many saprophytes, as *Monotropa*, *Neottia*, and *Orobanche*, are entirely wanting in root-hairs.

A great increase in the quantity of root-hairs may take place for a specific purpose, and organs of different value morphologically may become covered with them. They occur, for example, on the coleorhiza of Myrtaceæ, *Scabiosa atropurpurea*, and some grasses, for the purpose of fixing the seedling firmly in the soil. In *Psilotum triquetrum*, *Corallorhiza innata*, and *Epipogon Gmelini*, they are produced on the cauline organs, which perform the function of roots.

The root-hair is almost always simply an outgrowth of an epidermal cell. In exceptional cases the mother-cell subsequently forms a sheath round it, as in the prothallium of *Alsophila australis* and *Aspidium molle*. They are developed acropetally without any definite arrangement; rarely, as in *Nuphar*, *Elodea*, &c., they arise out of cells already formed. Their form does not vary greatly, though they are to a certain extent affected by external circumstances, contact, food-supply, &c. They may occasionally branch, and even twine. The longest root-hairs observed by the author were those of the Marchantiaceæ, 18 mm., *Trianea*, 8 mm., *Potamogeton*, 5 mm., and *Elodea*, 4 mm.

**Sieve-tubes of Cucurbita.**[*]—According to A. Fischer, a transverse section of an internode of *Cucurbita* shows two systems of sieve-tubes, one belonging to the vascular bundles, and the other situated within the sclerenchymatous ring so characteristic of the Cucurbitaceæ, which lies beneath the strongly developed collenchymatous tissue. This occurrence of sieve-tubes in the cortex is, as far as is at present known, entirely confined to this order. The sieve-tubes of the separate vascular bundles are united into one system with one another and with those of the cortex for the conveyance of nitrogenous formative materials, by fine transverse uniting strings which press through the fundamental tissue. On the other hand the peripheral sieve-tubes can only be in communication with this system through the nodes, as no uniting strings have been observed to pass through the sclerenchymatous ring, which is closed on all sides.

**Spines of the Aurantiaceæ.**[†]—J. Urban has investigated the morphological value of the spines, which occur singly or in pairs, in the axils of the leaves of many but not all Aurantiaceæ, and which have been generally regarded as metamorphosed axillary shoots. From comparison with unarmed species, and from the history of development, Urban regards them, on the contrary, as the metamorphosed lowermost leaves of the primary axillary shoot. Intermediate forms are exhibited by some species of *Citrus*.

**Tubers of Myrmecodia echinata.**[‡]—M. Treub describes the remarkable tuberous stem of the epiphytal Rubiaceous genera *Myrmecodia* and *Hydnophytum*, which are permeated by passages inhabited by immense numbers of ants. He states that the passages are not burrowed by the ants, but are formed by the disappearance of cells which become entirely enveloped in layers of cork. Their object is not to protect the colonies of ants, or to supply them with food, but rather to facilitate communication between the inclosed air-spaces and the external atmosphere.

**Chlorophyll-grains, their Chemical, Morphological, and Biological Nature.**[§]—A. Meyer continues his previous investigations on this subject.[‖]

He expresses a strong opinion against the chlorophyll-grains being surrounded by a membrane. Where a denser portion becomes separated on contact with water, this must not be regarded as originally present; for if so, it would become thinner by the swelling of the surrounding protoplasm, or by tensions resulting from endosmotic action, which is not the case. Pringsheim's lipochlor and hypochlorin he regards as still hypothetical.

Observations on *Acanthephippium* and *Asphodelus* show that the autoplast of the chlorophyll-grains consists of a light-coloured matrix in which are imbedded green grains. The phenomena of swelling and other reactions are explained by the following hypothesis:—Every grain contains an invisible inclosed substance soluble in water; the solution of this stretches the framework, which swells at the same time, and which forms a relatively dense envelope around the inclosed substance. The oily substances inclosed, he determined not to consist of a fixed (fatty) oil.

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[*] Ber. Deutsch. Bot. Gesell., i. (1883) pp. 276–9.

[†] Ibid., pp. 313–9 (1 pl.).

[‡] Ann. Jard. Bot. Buitenzorg, iii. pp. 129–60 (5 pls.). See Bot. Centralbl., xvi. (1883) p. 103.

[§] Meyer, A., 'Das Chlorophyll-korn, in chemischer, morphologischer, u. biologischer Beziehung' (3 pls.). Leipzig, 1883. See Bot. Centralbl., xv. (1883) p. 332.

[‖] See this Journal, iii. (1883) p. 239.

In the passage of autoplasts into anaplasts and chromoplasts, chemical and morphological differences are observable. The former are shown by the different behaviour towards reagents; the latter consist of a change in the structure, size, and mass of the trophoplast.

The form of the trophoplast is altered first of all by foreign bodies which grow in or on it. The autoplasts of many plants also undergo a change of form under the influence of rays of light. The position of the trophoplasts within the cells is also not fixed, light and gravitation causing variations in this respect.

From the investigation of starch-grains in parenchyma-cells of colourless stems, petals, fruits, seeds, and scales, the author draws the conclusion that wherever starch-grains occur, trophoplasts are also present, in or on which the starch-grains grow. The viridescence of ordinarily colourless parts of plants always depends on the transformation into autoplasts of anaplasts already present in the colourless cells. Wherever looked for, in parenchyma-cells, epidermal cells, sclerenchymatous cells, and sieve-tubes, the author always found trophoplasts.

In all cases where chlorophyll-grains are formed by the investment of starch-grains with viridescent protoplasm, the first stage is always the formation of trophoplasts. Observations on the development of the autoplasts of *Allium Cepa* and *Elodea* led to the conclusion that trophoplasts never arise from a differentiation of the protoplasm; but that they always multiply by division, and, with the protoplasm in which they are imbedded, always pass in a young and small condition into the daughter-cells on the division of a meristem-cell; there they increase further by division, grow with the cell either into anaplasts or into autoplasts and chromoplasts, and usually disappear with the death of the cell.

**Mechanism of the Splitting of Legumes.**[*]—According to C. Steinbrinck, the splitting of legumes is chiefly the result of hygroscopic tensions between the ligneous layer and the outer epidermis, alone or together with the hypoderm. These tensions are caused not only by the greater capacity of the ligneous layer for swelling, but depend essentially on the cross position of the cells of both tissues, which contract more in the transverse than in the longitudinal direction. This difference of contraction being greatest in the direction of the tangential transverse diameter of the ligneous fibres, these bring about a spiral curving inwards of both valves of the legume, which causes them eventually to spring asunder. In the different genera and species this curvature is more or less strengthened by the capacity for swelling of the masses of cellulose in the ligneous layer increasing more or less from the outside inwards.

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[*] Ber. Deutsch. Bot. Gesell, i. (1883) pp. 270–5.

**Aerial Vegetative Organs of Orchideæ in relation to their Habitat and Climate.**[*]—An examination of the structure of a large number of both native and tropical Orchideæ leads P. Krüger to the following general conclusions on this subject:—Starting from the native species, there may be seen, both in the foliar and axial organs, a series of gradual variations, which increase in importance as the climatic conditions of the species vary from ours. In one group of tropical orchids the original herbaceous habit is still maintained; while contrivances to suit other conditions are perfected in changes in the parenchyma, having for their purpose the absorption of the water necessary for the plant, and protection from transpiration. In a further stage the herbaceous form is abandoned as unsuitable, and the succulent form assumed; while in a third type the development of a mechanically firm and resistant system strengthens the epidermal tissue, or assists in the formation of special receptacles for water, or a combination of the two means. All these changes are accompanied by corresponding changes in the cuticle, having for their object the diminution of transpiration in tropical orchids.

**Assimilation of Carbonic Acid by Protoplasm which does not contain Chlorophyll.**[†]—By experiments on *Penicillium glaucum*, J. Reinke finds that all the carbon-acids tested, with the exception of carbonic, formic, and oxalic acids, are of equal value for its nutrition, but are useful only when in combination with bases. The methyl-group can in many cases supply the fungus with carbon; as also can the group $C_6 H_5$. Before it becomes serviceable to the plant, the carbon of the acids must apparently enter into combination with hydrogen, in consequence of a process of reduction brought about by the assistance of water, and by means of protoplasm.

**Artificial Influences on Internal Causes of Growth.**[‡]—E. Wollny points out that the reason why the secondary shoots of woody plants grow more rapidly when the main stem is decapitated, is not merely that they receive a better supply of nourishment, but that the conditions of the soil are altered through greater access of moisture and warmth. The popular idea that vegetation keeps the ground moist is exactly the reverse of the truth.

**Absorption of Food by the Leaves of Drosera.**[§]—By a series of experiments, M. Büsgen has confirmed in a very striking manner the observations of Rees and Darwin as to the capacity of *Drosera rotundifolia* for absorbing nutriment through the leaf. The number of inflorescences and capsules was found to average very much higher (from three to five times as many), when the leaves were fed with insects, compared with those not so fed under similar circumstances, even when an abundant supply of a nutrient fluid was furnished to their roots.

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[*] Flora, lxvi. (1883) pp. 435–43, 451–9, 467–77, 499–510, 515–24 (2 pls.).

[†] Reinke's Unters. Lab. Göttingen, Heft 3. See Bot. Ztg., xli. (1883) p. 551.

[‡] Wollny's Forsch. Geb. Agrikulturphysik, vi. (1883) pp. 97–134. See Biol. Centralbl., iii. (1883) p. 385.

[§] Bot. Ztg., xli. (1883) pp. 569–77, 585–94.

**Mechanical Action of Light on Plants.**[*]—F. Cohn has investigated not so much the cause of the apparently spontaneous movements of the lower plants and of animals, as the forces which induce those movements to assume certain definite directions.

Non-chlorophyllaceous organisms, such as monads and the zoospores of fungi, move freely in every direction indifferently in reference to the incidence of the rays of light.[†] Diatoms and Oscillarieæ, coloured respectively by phæophyll and phycochrome, always prefer light to darkness, and accumulate therefore on the surface of the water. When the field is equally illuminated in all directions, diatoms are distributed uniformly through the water, and Oscillarieæ radiate equally in all directions. Green microscopic organisms which contain chlorophyll, such as Euglenеæ, Volvocineæ, and the zoospores of most algæ, always display a certain polarity, one end being destitute of chlorophyll and usually provided with cilia and a red "eye-spot," and being also more pointed in comparison to the other end, which is coloured a deep green. The pointed end is always the anterior end in the "swarming" motion; and this advancing motion is always accompanied by a rotating movement round the longitudinal axis which passes through the two ends; the direction of this rotation varies in different organisms. A number of experiments undertaken by Cohn show that when the direction of the incidence of the light on the field of view is made to vary, the direction of the motion of these green organisms varies with it; they always seek light and avoid darkness. But it is a remarkable fact in connection with this, that it is the direction rather than the intensity of the light that seems to influence them; as is seen when the light is reflected on to the field of view from a mirror. Reflected light appears to have no more effect in influencing the direction of their movements than absolute darkness. Experiments with coloured glasses show that it is only the more refrangible actinic rays which have this effect on the movements of minute organisms; the less refrangible, which have no chemical action, have also no effect of this kind. A few exceptional organisms display a power of motion in the opposite to the ordinary direction.

A comparison of these movements with those of artificial euglenas which are made to evolve carbon dioxide from one end, shows that the direction of the movement is dependent on the decomposition of carbon dioxide by the aid of the organism which contains chlorophyll, and hence on its polarity.

These movements of green swarm-spores and similar bodies are compared by the author with the phototonic movements of the organs of plants, on which many observations have recently been made, especially by Stahl.[‡]

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[*] JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 179–86.

[†] With the exception, however, of bacteria, as shown by Engelmann. See this Journal, ii. (1882) pp. 380, 656; iii. (1883) p. 256.

[‡] See this Journal, ii. (1882) p. 373.

**Action of the Amount of Heat and of Maximum Temperature on the Opening of Flowers.**[*]—W. von Vogel states, as the results of a series of experiments, that the maximum temperature of the day has seven times greater influence on the opening of flowers than the average daily temperature. The mode of obtaining this result is detailed in the paper.

**Behaviour of Vegetable Tissues towards Gases.**[†]—J. Boehm describes an apparatus which he has contrived for the purpose of testing the variations, under different conditions, in the absorption of gases by vegetable tissues, by starch, and by coal. One of the most interesting of his conclusions is that the cell-wall is more permeable for oxygen than for nitrogen. Dry filings of wood and of starch-grains absorb four or five times their weight of carbonic acid, while cork absorbs comparatively little. Carbonic acid, oxygen, and hydrogen all become compressed in closed cells, owing to their greater diffusibility as compared to nitrogen.

**Influence of External Pressure on the Absorption of Water by Roots.**[‡]—J. Vesque has carried out a series of experiments on this subject, chiefly on two plants, one woody, the oleander, and the other herbaceous, the garden bean. The following is a summary of the results arrived at:—

1. The absorption of water by the roots of the oleander depends on external pressure; it seems to augment in proportion to the difference between the external pressure and that of the air contained in the woody mass of the root.

2. Osmose does not appear to be always very active; for, in diminishing the atmospheric pressure to about 60 cm. of water, absorption is arrested.

3. In the conditions of the experiments the pressure of the internal air is not very different from that of the atmosphere. It is mostly less from zero to 9 cm. of mercury; in one instance only did the internal pressure exceed that of the atmosphere by 1 cm. of mercury.

4. The effect of pressure on the oleander is sufficient for a sudden change of barometric pressure to cause a sensible disturbance in the absorption of water by the roots.

5. The garden bean was much less influenced by external pressure, as respects the absorption of water by the roots, than the oleander. There certainly is some influence, but it is ordinarily imperceptible among fluctuations resulting from changes of transpiration or from other secondary causes.

**Contrivances for the Erect Habit of Plants, and Influences of Transpiration on the Absorption of Water.**[§]—V. Meschayeff does not agree with Schwendener's view that there is a special tissue-system for the purpose of maintaining organs in an erect condition; he considers, on the contrary, that all the different tissues may be adapted to this special purpose.

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[*] Bull. Soc. Imp. Nat. Moscou, lviii. (1883) pp. 1-13. See Bot. Centralbl., xvi. (1883) p. 145.

[†] Bot. Ztg., xli. (1883) pp. 521-6, 537-50, 553-9.

[‡] Comptes Rendus, xcvii. (1883) pp. 718-20.

[§] Bull. Soc. Imp. Nat. Moscou, 1883, pp. 299-322.

The process of the absorption of water he explains as follows:—Transpiration attracts, so to speak, upwards the osmotic force, which is met by the flow of sap from all the neighbouring parts of the stem, especially in the elongated elements. The diminution of pressure which results brings into play from below the turgidity of the stem and the elasticity of the cortex; this causes increased activity in the root, which brings about an accumulation of water in the lower parts of the plant and an increased elevation of the sap. Capillarity and air-pressure play only a secondary part.

**Sap.***—J. Attfield gives an account of observations made on sap exuding from a wounded silver birch tree. A branch 7 inches in diameter, had been lopped off a tree 39 ft. high, about 10 ft. from the ground, before the leaves had expanded, leaving a wound about an inch in diameter, from which sap dropped. A bottle was suspended so as to catch the sap, and from observations it was found that the flow was apparently faster in sunshine than in the shade, and by day than by night, and altogether amounted to about 5 litres a day; this had been running for 15 days, but how long it would continue is uncertain. The sap was clear and bright, sp. gr. 1·005, had a faintly sweet taste and a slightly aromatic odour. After 12 hours it deposited a trace of a sediment, which, when examined microscopically, was found to consist of parenchymatous cells and a few so-called sphere-crystals. The liquid contained 99 per cent. water and 1 per cent. solid matter, which was composed mainly of sugar, 91 per cent., the other constituents being ammonium salts, albuminoids, nitrates, phosphates, and organic salts of calcium and magnesium, mucilage, and traces of nitrites and potassium salts. It had calcium and magnesium salts in solution equal to 25 degrees of total permanent hardness. It contained a ferment capable of converting starch into sugar, and when exposed to the air, it soon teemed with bacteria, the sugar being changed into alcohol.

**Solid Pigments in the Cell-sap.**†—The petals of flowers are far more often coloured by a pigment soluble in the cell-sap than by one in a solid granular form. Of 200 species examined by P. Fritsch, only 30 contained solid pigments in the cells either of the petals or of the fruits.

Far the most common of these solid pigments is yellow, much the greater number of yellow flowers, including nearly all yellow Compositæ, being indebted for their colour to substances of this nature. Exceptional instances of soluble yellow pigments occur in the petals of *Dahlia variabilis*, *Althæa Sieberi*, and *Tagetes*, and in the hairs of a good many species. Solid yellow pigments are described in *Impatiens longicornu*, where they vary greatly in size and form, *Tropæolum majus*, where the various shades of colour in the flower are due to a substance of this description imbedded in a brown cell-sap, *Œnothera biennis*, *Cerinthe aspera*, *Calendula officinalis*, *Tagetes glandulifera*, *Viola tricolor*, *Rudbeckia laciniata*, *Digitalis ambigua*, and *Salpiglossis variabilis*. The particles of the pigment are often in a state of active molecular movement; they are always coloured green by iodine, and are soluble in concentrated sulphuric acid with a deep blue colour. In some other chemical reactions they vary. The pigment appears to be always imbedded in a matrix of protoplasm.

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* Pharm. J. Trans., xiii. (1883) pp. 819–20. Cf. Journ. Chem. Soc.—Abstr., xliv. (1883) pp. 1164–5.

† Pringsheim's Jahrb. Wiss. Bot., xiv. (1883) pp. 185–231 (3 pls.).

A solid red pigment was observed in the fruits of *Rosa canina*, *Pyrus aucuparia* and *Hostii*, *Convallaria majalis*, *Bryonia dioica*, and in the aril of *Euonymus latifolius* and *europæus*, *Celastrus candens* and *Taxus baccata*.

The red pigment in the cortical portion of the root of the carrot is of a very peculiar kind, resembling long pointed crystals. The cells of the scarlet berry of *Arum maculatum* contain a great quantity of minute brownish-red granules.

Insoluble violet pigments are rare, but occur in *Thunbergia alata* and *Delphinium bicolor*; while blue granules are found in the fruit of *Viburnum Tinus*. Brown insoluble pigments were found only in seaweeds, *Fucus vesiculosus* and *Furcellaria fastigiata*.

The development of the coloured granules does not end with their acting as pigments; after this period they go through a variety of changes of development or degradation.

**Movement of Sap in Plants in the Tropics.**[*]—Observations made in Europe show that the activity of the circulation of the sap has two periods of maximum in the 24 hours, one in the morning, the other, less pronounced, in the afternoon. V. Marcano has carried on a series of experiments to determine whether the same is the case in the tropics. They were made at Caracas in Venezuela, about 10½° N. lat., at a height of 869 metres above the sea-level, where the barometric pressure scarcely varies from 1 to 2 mm., and the thermometer not more than 3° in the 24 hours. The plants observed were *Carica Papaya* and a liane. By means of a manometer, two very well marked maxima in the rapidity of the movement of the sap were detected, the first between 8 and 10·15 A.M., after which the curve rapidly sinks to zero, remains there for a time, and then rises, between 1 and 3 P.M., to a much smaller height than in the morning, sinking then again gradually to zero, the activity commencing again after sunrise.

**Exudation from Flowers in Relation to Honey-dew.**[†]—T. Meehan refers to the fact that standard literature continues to teach that the sweet varnish-like covering often found over every leaf on large trees, as well as on comparatively small bushes, was the work of insects, notably Aphidæ. Dr. Hoffman, of Giessen, who in 1876 published a paper on the subject, is the only scientific man of note who takes ground against this view. He met with a camellia, without blossoms, and wholly free from insects, and yet the leaves were coated with "honey-dew." He found this substance to consist of a sticky colourless liquid, having a sweetish taste, and principally gum, and Mr. Meehan has often met with cases where no insects could be found, as well as others where insects were numerous, and where in the latter case, the attending circumstances were strongly in favour of the conclusion that the liquid covering was the work of insects. He considers that few scientific men have any knowledge of the enormous amount of liquid exuded by flowers at the time of opening, and he has seen cases where the leaves were as completely covered by the liquid from the flowers, as if it had exuded from the leaves, as he considers Dr. Hoffman had good grounds for believing is often the case.

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[*] Comptes Rendus, xcvii. (1883) p. 340.

[†] Proc. Acad. Nat. Sci. Philad., 1883, p. 190.

What is the object of this abundant exudation of sweet liquid and liquid of other character from leaves and flowers? We are so accustomed to read of nectar and nectaries in connection with the cross-fertilization of flowers, that there might seem to be no room for any other suggestion. But plants like *Thuja* and *Abies* are anemophilous, and, having their pollen carried freely by the wind, have no need for these extraordinary exudations, from any point of view connected with the visits of insects to flowers. In the case of *Thuja*, Sachs has suggested another use: "The pollen-grains which happen to fall on the opening of the micropyle of the ovules are retained by an exuding drop of fluid, which about this time fills the canal of the micropyle, but afterwards dries up, and thus draws the captured pollen-grains to the nucellus, where they immediately emit their pollen-tubes into its spongy tissue. In the Cupressineæ, Taxineæ, and Podocarpeæ, this contrivance is sufficient, since the micropyles project outwardly; in the Abietineæ, where they are more concealed among the scales and bracts, these themselves form, at the time of pollination, canals and channels for this purpose, through which the pollen-grains arrive at the micropyles filled with fluid."*

In his former observations on liquid exudation in *Thuja* and other plants, Mr. Meehan was inclined to adopt the suggestion of Sachs as to the purpose of the liquid supply; but as it was present in *Abies* so long after fertilization must have taken place, and as it was held up in the deep recesses of the scales of the pendent cone, where it could hardly be possible the wind could draw up the pollen, we must look for other reasons, which, however, do not yet seem to be apparent.

**Latex of the Euphorbiaceæ.**†—S. Dietz has studied the composition of the latex of various plants, especially of the Euphorbiaceæ. He finds almost invariably crystalline substances to be present which crystallize out when the latex is made to coagulate under the cover-glass. In the Euphorbiaceæ he distinguishes three kinds of crystallizable substances, as follows:—

1. Sphærocrystals. These differ in their mode of development from any hitherto known. In the coagulated latex of the Euphorbiaceæ

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* Sachs' 'Text-book of Botany,' 2nd Engl. ed., 1882, p. 513.

† M. Tud. Akad. Ertek., xii. (1882) 23 pp. (2 pls.). See Bot. Centralbl., xvi. (1883) p. 132.

there arise separate dense spherical groups, becoming gradually denser as the solvent evaporates, in consequence of which, when crystallization commences, an empty space is formed in the interior of the sphærocrystal. The sphærocrystals of the Euphorbiaceæ are organic in their nature, and all belong to the inulin type. They occur in especially large numbers in the coagulated latex of *Euphorbia splendens*, *heptagona*, and *erosa*, in the last species with a diameter of 0·8–1·0 mm.; also, less developed, in axial organs of the two first-named species. The latter differ from other sphærocrystals in dissolving in glycerine after from four to eight weeks' immersion.

2. Resin-crystals were found in the latex of all species of Euphorbiaceæ examined, belonging to the cubical system. They are of three kinds:—viz. (1) forming angular dendritic groups; (2) groups consisting evidently of closely packed separate crystals; (3) those which occur only isolated.

3. Crystals consisting especially of potassium and calcium malate. These belong mostly to the rhombic and to the bi- and uniaxial systems. True crystals of salts of malic acid also occur, to which he gives the name of stellate crystals.

**Crystalloids in Trophoplasts, and Chromoplasts of Angiosperms.***—Pursuing his previous investigations of starch-generators or trophoplasts,† A. Meyer has come to the conclusion that the bodies described by Schmitz in algæ under the name of pyrenoids‡ are identical with the crystalloids of proteinaceous substances which frequently occur in the fusiform trophoplasts of many flowering plants. They differ from the protoplasm in having no framework or plastin. The crystalloids of *Phajus* swell and dissolve with greater or less readiness in water; they are completely soluble in solution of chloral hydrate; when hardened by alcohol they are soluble in cold potash-lye, but not when hardened by mercuric-chloride; they are colourless, homogeneous, and doubly refractive; when hardened by picric acid they are distinctly stained red by alum-carmine, but less easily than the nucleus. In most of these characters they agree altogether with Schmitz's pyrenoids.

The autoplasts of foliage-leaves are usually formed as follows:—The comparatively small trophoplast of a meristem-cell, which is at first colourless and globular, or more or less regularly stretched by the surrounding protoplasm, begins to grow slowly with the protoplasm of its mother-cell. The framework or plastin thus increases in mass, and grains of chlorophyll are formed within it, and possibly other at present unknown substances soluble in alcohol. The mature autoplast appears to have changed its structure before it exhibits any change in colour. The trophoplasts of the petals of angiosperms are usually smaller than those of the foliage-leaves, but do not differ from them in any essential respect. The trophoplasts of foliage-leaves may be classed under the four following types:—(1) colourless during the whole of their existence; (2) at first colourless, then forming chlorophyll, which remains till the death of the cell; (3) colourless and forming chlorophyll, which afterwards passes over into xanthophyll; (4) colourless, producing xanthophyll directly sooner or later; (5) coloured by xanthophyll during the whole of their existence.

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* Bot. Ztg., xli. (1883) pp. 489–98, 505–14, 526–31.

† See this Journal, ii. (1882) p. 368.

‡ Ibid., iii. (1883) p. 405.

The chromoplasts of flowers may be classified as follows:—A. In the last stage of development round, or (in the epidermis) more or less angular from mutual pressure, never fusiform. (*a*) They produce comparatively little xanthophyll, and appear at last more or less flat and irregularly filled with vacuoles; xanthophyll light yellow. (*b*) They produce comparatively little xanthophyll, and contain till the end a great quantity of starch; xanthophyll light yellow. (*c*) They produce a comparatively large quantity of xanthophyll, and are finally more spherical: *α*. with none or very few vacuoles, and xanthophyll reddish yellow; *β*. xanthophyll light yellow. (*d*) They produce a comparatively large quantity of xanthophyll, which finally lies within the protoplasm in a granular form. B. They finally become fusiform from the tendency of the xanthophyll to crystallize; xanthophyll usually dark or reddish yellow. C. They produce crystalloids in or on them, by which they are more or less stretched. Of each of these types, between which there are transitional forms, the author cites examples.

**Formation and Resorption of Cystoliths.***—According to J. Chareyre, the reserve-materials of the Urticineæ and Acanthaceæ consist of aleurone-grains, each of which contains a globoid; *Acanthus* and *Hexacentris* also contain starch. The globoids which constitute the calcareous reserve-materials of the seed disappear more completely if the plant is cultivated in pure sand than in limestone or ordinary soil; but they do not contribute to the formation of cystoliths. In pure silica the pedicel only of the cystoliths is formed. In darkness only rudimentary cystoliths are produced.

In the Acanthaceæ etiolation and death produce no effect on the cystoliths; but in *Ficus elastica* the calcium disappears in darkness after about fourteen days. The resorption of the calcium carbonate does not result from its passing over into the alkaline carbonate. Under normal conditions, the cystoliths are formed again in a month or six weeks. Calcium oxalate behaves in the same way. In etiolated leaves of *Ficus*, sulphuric acid produces a larger quantity of crystals of gypsum than in normal leaves.

**Function of Organic Acids in Plants.**†—W. Detmer regards the organic acids as having a very important function as the chief promoters of osmose, and consequently of the turgidity of the cell. The conversion of starch into sugar is also greatly dependent on the presence or absence of free acids; the presence of carbonic acid and of small quantities of hydrochloric, nitric, phosphoric, citric, and oxalic acids promoting this conversion by means of starch in a remarkable manner. Absence of these acids not only decreases the transformation of starch but also the turgidity of the cells; but this conversion can only be effected by the combined action of the acid and of the ferment.

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* Comptes Rendus, xcvi. (1883) pp. 1594–6. Cf. this Journal, iii. (1883) p. 389.

† SB. Jenaisch. Gesell. Med. u. Naturw., 1883, pp. 47–9.

**Formation of Ferments in the Cells of Higher Plants.***— A series of experiments by W. Detmer leads him to the conclusion that in the cells of higher plants no transforming ferment can be produced in the absence of oxygen. Access of free oxygen is an essential condition for the formation of diastase, and the ferment is unquestionably formed by means of oxygen out of the albuminoids or proteids of the protoplasm.

**Poulsen's Botanical Micro-Chemistry.**†—This book, after having been translated from the original Danish into German, French, and Italian, at last appears in English, having been translated, with the assistance of the author, and considerably enlarged by Professor W. Trelease, of Wisconsin, U.S.A.

We referred to the original work (i. 1881, p. 772) but we may quote the following paragraphs from the introduction as showing its scope:—

"Physics has thus striven to bring the Microscope to as great a degree of perfection as possible; it remains for chemistry to find means of recognizing and rightly understanding the composition of the objects we investigate. In other words, if we employ a thorough system of chemical analysis with the optical apparatus, we shall be able to answer all questions lying within the range of possibility. It is this analysis applied to objects under the Microscope that we designate by the word *micro-chemistry*.

I have endeavoured to successively make the reader acquainted with the most valuable reagents used in micro-chemistry, i.e., with those substances whose action on the bodies to be studied allows their chemical composition and nature and sometimes their physical structure to be recognized. In the first section I have considered the chemicals used in the laboratory; in the second, the vegetable substances to be tested for, and the reactions by which they are known . . . At the close of the first section I have introduced a short chapter on media for the preservation of permanent preparations, to which are added a few words on the cements used in mounting."

The book ought to be in every microscopist's library.

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* Bot. Ztg., xli. (1883) pp. 601–6.

† See *infra*, Bibliography *a*.

## B. CRYPTOGAMIA.

### Cryptogamia Vascularia.

**Classification of Ophioglossaceæ.***—K. Prantl gives the following characters of the primary subdivisions of the genera belonging to this family:—

I. *Botrychium.*
  Sectio 1. *Eubotrychium.* Folia semper glaberrima, stomata in utraque pagina obvia; lamina oblonga vel deltoidea, ad summum bipinnata; petioli fasciculi bini præter binos in pedunculum exeuntes; xylema rhizomatis indistincte seriatum. 5 sp.
  Sectio 2. *Phyllotrichum.* Folia juvenilia sæpe et adulta pilosa, stomata infera; lamina deltoidea, bi- ad quinquepinnata; xylema rhizomatis distincte seriatum. 10 sp.
II. *Helminthostachys.* 1 sp. (*H. zeylanicum*).
III. *Ophioglossum.*
  Sectio 1. *Euophioglossum.* Rhizoma hypogæum, præter involucri margines glabrum, pedunculus solitarius e petiolo vel basi laminæ oriundus, petioli fasciculi basi tres, intra laminam plus minus ramosi, stomata utrinque obvia, rarius supra parca vel nulla, radicis fasciculus monarchus. 27 sp.
  Sectio 2. *Ophioderma.* Rhizoma epidendrum papillosum; pedunculus solitarius e lamina oriundus; lamina fasciæformis integra vel dichotome lobata, basi sensim in petiolum teretem angustato, nervo mediano hinc inde laterales emittente, petioli fasciculi numerosi, stomata utrinque obvia, radicis fasciculus tri- ad tetrarchus. 1 sp. (*O. pendulum*).
  Sectio 3. *Cheiroglossa.* Rhizoma epidendrum longepilosum; pedunculi plures, anteriores e margine basali laminæ dichotome lobatæ oriundi, nervis dichotomis; petioli fasciculi numerosi; stomata infera; radicis fasciculus diarchus. 1 sp. (*O. palmatum*).

**Structure of Helminthostachys.**†—From an examination of *Helminthostachys zeylanica* from Borneo, K. Prantl discusses the relationship between this and the two remaining genera of Ophioglossaceæ.

It is distinguished from both *Ophioglossum* and *Botrychium* by its dorsiventral horizontal rhizome, bearing two rows of leaves on its dorsal and several rows of roots on the lateral and ventral sides. Only a single leaf unfolds each year. The course of the fibrovascular bundles resembles that in *Botrychium* rather than in *Ophioglossum*; there is no median bundle; but, on the contrary, there are four placed diagonally to the base of the leaf-stalk. In the absence of any sclerenchyma in the collateral structure of the bundles in the stem and leaf, in the absence of palisade-parenchyma, and in other points, *Helminthostachys* presents a complete agreement with the other two genera.

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* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 348–53.

† Ibid., pp. 155–61.

The most striking peculiarity of *Helminthostachys* is the fertile portion of the leaf, which is densely covered with sporangia, between which are still green portions of the mesophyll. Each of these green portions is the sterile apex of a branchlet.

### Muscineæ.

**Structure and Development of certain Spores.***—H. Leitgeb describes a number of examples of departure from the ordinary structure of the spores of cryptogams, viz. where the membrane is composed of two distinctly differentiated coats like the cell-wall of pollen-grains, mostly in the case of Hepaticæ. With Strasburger he retains the same terminology for the two coats, as for those of pollen-grains, viz. extine and intine; but restricts the latter term to an inner layer consisting of pure cellulose. In *Osmunda*, *Ceratopteris*, and *Gleichenia*, for example, there is no true intine or endospore, the inner layer of the spore-membrane being completely cuticularized, and showing none of the reactions of cellulose. Again, in many thin-walled spores which germinate immediately after maturity without any period of rest, as in those of many Jungermanniaceæ, *Jungermannia*, *Lophocolea*, *Lepidozia*, *Blasia*, &c., there is only one membrane with cuticularized outer layer, the whole of which is used up in the formation of the germinating filament. This is exactly comparable to certain pollen-grains, as those of *Naias* and *Orchis*, and in a certain sense also those of *Allium fistulosum*, where there is only one membrane, the whole of which goes to the formation of the pollen-tube. In other cases again, an inner layer of cellulose employed, in the formation of the germinating filaments, is formed only immediately before the period of germination.

In many thick-walled spores of Hepaticæ, the wall always consists of more than two distinctly differentiated layers; the exospore, extine, or sporoderm being composed of two separable layers, similar to the well-known case of *Equisetum*.

One type of this structure is furnished by *Preissia*, *Duvallia*, *Reboulia*, *Fimbriaria*, and *Plagiochasma*. The intine, which turns blue and swells strongly with chloriodide of zinc, is inclosed in a cuticularized layer, which is entirely structureless, and may be termed the extine. This is again inclosed in a third layer with folded protuberances, and elevated like a bladder on one side. But slightly different are the spores of *Grimmaldia* and *Boschia*.

*Corsinia* resembles these genera in the structure of the intine and extine, but that of the outermost layer is very different. It is of uniform thickness (as much as 20 $\mu$), and is composed on the dorsal side of polygonal (usually hexagonal) plates, while on the ventral side it is a continuous perfectly smooth shell. Where the dorsal and ventral sides meet, is a projecting seam.

In *Sphærocarpus*, the spores remain united into tetrahedra; but this is not, as in *Lycopodium*, the result of a simple attachment of the adjacent walls; they are inclosed in a common membrane which is closely connected with the walls which separate the spores from one another, and consists in fact of layers of the mother-cells of the spores. This membrane is beautifully sculptured on the outside by projecting reticulate bands; and the outer surface of the extine is also similarly sculptured. The history of development of these spores and of the sculpture is gone into in detail; and the author shows that in *Corsinia* also, and probably also in the other thick-walled spores, the outermost layer is developed, as in *Sphærocarpus*, from the membrane of the mother-cell, and from its innermost layers, the special mother-cell; its formation beginning only after the formation of the true extine, and before the peripheral layers disappear.

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* Ber. Deutsch. Bot. Gesell., i. (1883, pp. 246–56.

## Fungi.

**Alkaloids and other Substances extracted from Fungi.***—C. J. Stewart considers that the chemistry of fungi is by no means in a satisfactory state. Many of the existing statements are rendered doubtful by a bad identification of the species. It is also difficult to obtain a sufficient amount of raw material, and its perishable nature interposes another obstacle. Beyond this, the research itself is so difficult and expensive, and the question of profitable result is so remote to ordinary minds, that few qualified chemists have even ventured upon the task. He has accordingly endeavoured to collect together such facts as were scattered in chemical literature, and to explain them as untechnically as was possible with due regard to exactness and truth. The paper is not capable of being usefully abstracted, but it deals with the sugars found in fungi, oils and fats, vegetable acids, resins, colouring matters, trimethylamine, betaine, muscarine, and amanitine ($C_5 H_{15} NO_2$). This is identical with the animal bases choline and neurine, and is another link between fungi and the animal kingdom. The production of these bodies artificially, which has been accomplished, is of great interest, as very few natural alkaloids have yet been artificially made; and the success leads us to hope that we may some day produce such medicinal alkaloids as quinine and morphia by chemical means at a cheaper rate.

**Development of Ascomycetes.**†—E. Eidam describes a new genus of fungi, *Eremascus*, which he regards as, with the exception of *Saccharomyces*, the simplest type of the Ascomycetes, the entire fructification being reduced to a single naked ascus. It occurs as a white pellicle on the surface of extract of malt. On the much-branched mycelium there appear, directly on the septa, and on both sides, two precisely similar protuberances, which grow into hyphæ, and coil spirally round one another even in their youngest stages. The spiral consists of several coils; the apices of the two hyphæ touch one another, and the septum becomes absorbed and their contents completely coalesce. The point of coalescence, which is at first small, increases into a spherical body, which becomes at length separated by septa from the rest of the spiral hyphæ. The remainder of these hyphæ perform the function of conducting cells, and the spherical body becomes an ascus, in which eight ascospores with double cell-walls are formed. The ascus is either quite solitary, or as many as four, with their conducting cells, stand at the same height on the mycelial filaments. The author classes *Eremascus* among the Gymnoascaceæ.

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* Grevillea, xii. (1883) pp. 44–9.

† JB. Schles. Gesell. vaterl. Cult., 1883, pp. 175–7.

A new species of *Gymnoascus* is described, *G. setosus*, found in quantities on a wasp's nest.

The author next gives a full description of the history of development of a species of *Sterigmatocystis*, which forms both conidiophores and asci in a very peculiar way. The perithecia are buried in a large hollow envelope formed of branched filaments, the ends of which swell up into colourless or slightly yellow thick-walled vesicles. Within this cushion are produced the asci. Two very fine hyphæ swell up at their apices, coil, one forming the "nucleus," the other branching and forming the wall of the perithecium. The young fructification has the remarkable property of its colourless contents turning a beautiful blue on addition of ammonia or potash, which changes to red when an acid is added. This colouring substance occurs only in the wall of the perithecium, which, when ripe, is nearly black, and in the ascospores, which are purple. These latter ripen very slowly, and, on germination, produce again the conidiophores of *Sterigmatocystis*.

In *Chætomium* (*C. Kunzeanum* Zopf) the origin of the fructification is a single thickish hypha which developes into a distinctly segmented spiral. In the further development Eidam agrees with Van Tieghem rather than with Zopf. A pseudo-parenchymatous ball is formed by the branching of a single spiral filament which is clearly distinguishable from the rest of the mycelium.

**Conidia of Peronospora.**[*]—M. Cornu gives a more exact description than any previous observer of the mode of abstriction of the conidia of *Peronospora*. In the middle of the septum which separates the conidium from its hypha is formed a soluble gelatinous layer. This accounts for the rapid development of *Peronospora* after rainy weather. Cornu disputes the possibility of the oospore directly producing zoospores on germination like the conidia, or rather the sporangium, as de Bary has described in the case of *Cystopus*. Each oospore, on the contrary, developes into a mycelial filament bearing a sporangium. Their germination depends greatly on moisture and temperature, as also on the depth at which they are buried in the soil. When at a considerable depth they may retain their power of germination for from two to five years.

**Pleospora herbarum.**[†]—Great confusion has resulted from authors having described under this name different organisms which have no genetic connection with one another. F. G. Kohl has carefully investigated its life-history, having sown the ascospores obtained from perithecia growing on the stems of *Levisticum officinale*. On the same host was found also the conidial form known as *Alternaria tenuis* Nees et Cord. The ascospores of the first form agreed precisely with those of *Pleospora Sarcinulæ* Gib. et Griff. Their cultivation gave rise to an abundant mycelium producing *Sarcinula*-conidia and subsequently perithecia, which again produced ascospores. The second form also gave rise to a mycelium indistinguishable from that of the first, producing immense quantities of green *Alternaria*-conidia, but no perithecia. The stylospores from pycnidia found on the same host gave rise to a mycelium which produced both pycnidia and *Alternaria*-conidia; but no proof was obtained of any genetic connection between the *Sarcinula*-conidia and perithecia on the one hand, and the *Alternaria*-conidia and pycnidia on the other hand.

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[*] Cornu, M., 'Etudes sur les Peronosporées. II. Le Peronospora des vignes.' 91 pp., 5 pls., Paris, 1882. See Bot. Centralbl., xv. (1883) p. 274.

[†] Bot. Centralbl., xvi. (1883) pp. 26–31.

*Cladosporium herbarum*, though frequently accompanying all these forms in nature, does not belong to the same cycle of development. It has two conidial forms; firstly, an elongated ellipse, unseptated, which are abstricted in clusters, and have a punctated membrane; secondly, also elliptical but shorter, divided into from one to three chambers, with smooth membrane, not constricted, or very slightly so, at the septa, and abstricted singly from the mycelial branches aggregated in tufts.

*Epicoccum herbarum* has also no genetic connection with *Pleospora*.

**Chytridiaceæ.**[*]—J. Schaarschmidt describes a new species of Chytridiaceæ, *Phlyctidium Haynaldii*, and proposes a fresh classification of the species living in water, according to the development of the mycelium. The mycelium appears to be wanting in *Olpidiopsis* and its allies; the naked plasmodium passes over immediately (*Olpidiopsis*) or indirectly (*Woronina*, *Rozella*, and perhaps *Achlyogeton*) into several zoosporangia. In *Chytridium* and *Phlyctidium* the mycelium is a simple filiform structure; it attains greater development in the genera *Rhizidium*, *Polyphagus*, *Cladochytrium*, *Obelidium*, *Zygochytrium*, and *Tetrachytrium*; it is septated and multicellular in *Catenaria*, *Polyrrhina*, and *Saccopodium*. The author found *Chytridium globosum* and *oblongum* parasitic on *Ulothrix zonata*.

**Phoma Gentianæ, a new Parasitic Fungus.**[†]—J. Kühn describes a newly discovered fungus, having its habitat on the stems, leaves, and buds of *Gentiana ciliata*, and takes the opportunity of denying that plants grown in mountainous districts are freer from such parasites than those of the lowlands.

**Chrysomyxa albida.**[‡]—Under this name J. Kühn describes a new species of parasitic fungus observed on the bramble (*Rubus fruticosus*) in the Black Forest. It forms small roundish white or yellowish white patches on the under side of the leaves, from 0·25 to 0·5 mm. in diameter. From these project threads which are the unbranched or the more or less branched spores, composed of a varying number of cells. Excluding the pedicel-cell, the number of cells of which the spores are composed is usually five or six, though there may be a larger or smaller number. The separate spore-cells are often very beautiful in form, bearing a distant resemblance to the teleutospores of *Puccinia coronata*. The walls of the cells are usually more or less thickened, and often with considerable projections; though the thickening is often entirely wanting. They are cylindrical or ovoid in form, but with considerable variations, the length varying from 17 to 47 $\mu$ and the breadth from 15 to 21 $\mu$; the terminal cell frequently differing very considerably from all the rest. A nucleus is present, but disappears before the commencement of germination. The spores germinate with great readiness, frequently even under the cover-glass.

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[*] Magyar Növen. Lapok, vii. (1883) pp. 58–63 (1 pl.) (Magyar and Latin). See Bot. Centralbl., xv. (1883) p. 370.

[†] Landw. Versuchs.-Stat., xxviii. (1883) pp. 455–6. Cf. Journ. Chem. Soc. Abstr., xliv. (1883) p. 1025.

[‡] Bot. Centralbl., xvi. (1883) pp. 154–7.

In larger patches the teleutospores are often accompanied also by the uredo-form. The uredospores also vary greatly in form, having perhaps an average diameter of about 26 $\mu$. They differ from those of species of *Phragmidium* which are often also found on the bramble, in the entire absence of paraphyses. They are probably identical with the bodies described by Fuckel as the æcidial fruit of *Phragmidium asperum*. The uredo-form occurs abundantly on other parts of the plant besides the leaves.

**Physoderma.***—J. Schröter describes this genus of parasitic fungi as characterized by being altogether destitute of a mycelium; the spores forming directly abundant masses of spores within the parenchymatous cells of the host. Small colourless lumps of protoplasm gradually swell up into a spherical form, and become invested first with a simple, afterwards with a thick coat. This process resembles the formation of the resting-spores of *Synchytrium*; but *Physoderma* differs from *Synchytrium* by the spores being formed in the parenchymatous and not in the epidermal cells of the host, and by the resting-spores of *Synchytrium* having a firmer inner layer of the cell-wall, so that the outer layer bursts easily.

The author has observed for some years in the neighbourhood of Breslau a very remarkable species of *Physoderma* on *Chenopodium glaucum*, and apparently confined to this species, completely deforming it, and causing the stem and leaves to assume a reddish or yellow colour. In the coloured pustules which appear in the summer are found very large zoosporangia with orange-coloured contents. From the base of the zoosporangium a dense tuft of very fine branched hyphæ penetrates into a parenchymatous cell of the host. Within this cell are formed very large zoospores endowed with very active motion, which pierce the tissue of the host and form new sporangia.

In the autumn are formed black pustules which contain the resting-spores, which are formed by a process of conjugation. The zoospores attach themselves to a cell-wall; from this spot proceed very long and delicate threads of protoplasm bearing at their apices small spherical vesicles. On the summit of these vesicles is a tuft of delicate, short, but often branched threads of protoplasm. Two of these cells appear to conjugate (though it would seem as if the act of conjugation has not been actually observed), the protoplasm passing from one into the other, which swells up greatly, being filled with protoplasm and drops of oil, and invested with a firm coat. The two conjugating cells place themselves one on the top of the other, and an open tubular communication is formed between them. The process presents the greatest resemblance to the formation of the spiny spores of Chytridiaceæ. *Physoderma* appears to be an intermediate form between the Chytridiaceæ and *Pythium* and the Peronosporeæ; and may also be related on the other hand to *Cladochytrium*.

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* JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 198–200.

**Bacilli of Tubercle.***—According to Prof. Rindfleisch, tubercular bacilli are best stained by fuchsin soluble in alcohol, but not in water. Two or three drops of a concentrated solution in 2–3 cm. of anilin-oil water are sufficient. The staining is especially good at 40° C. The bacilli are uniformly stained if a few drops of fuchsin are added to a mixture of equal parts of alcohol, water, and nitric acid.

**Microbia of Marine Fish.**†—In pursuance of their researches on this subject, L. Olivier and C. Richet have ascertained beyond doubt the spontaneous motility of the microbes obtained from living fish, as distinguished from mere passive or brownian movements. Motile organisms were found in living specimens of *Gadus luscus*, which had been only twenty-four hours in an aquarium, in the cephalo-rachidean and peritoneal fluids; in the peritoneal fluid of a *Blennius*; in the blood of the heart of *Gadus luscus*, and in the peritoneal fluid of a whiting.

The absence of putrefaction in the lymph or blood of a fish does not prove the absence of living microbes; some of the examples named above remained for months without alteration. A good nutrient fluid for their culture was found to be infusion of beef. The cephalo-rachidian fluid of a mud-fish was mixed with sterilized infusion of beef in one part of an exhausted tube. After three months no clouding appeared in it, but at the bottom was a minute whitish deposit. This contained mobile, short, flexuous bacilli, which were stained by methyl-violet.

**Physiology and Morphology of Alcoholic Ferments.**‡—C. E. Hansen describes the mode of formation of the ascospores of *Saccharomyces*, his description of which differs in several points from that of previous observers, especially Engel and Brefeld. He also contests van Tieghem's view that the formation of ascospores is a pathological phenomenon due to bacteria. He gives a detailed description of the characters by which the various species of *Saccharomyces* may be distinguished from one another. In all the species examined the ascospores were never developed below a minimum temperature of from 0·5° to 3° C., or above a temperature of about 37·5° C.

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* SB. Phys.-med. Gesell. Würzburg, 1882. See Bot. Centralbl., xvi. (1883) p. 18.

† Comptes Rendus, xcvii. (1883). Cf. this Journal, iii. (1883) pp. 402, 884.

‡ Meddel. Carlsberg Lab., ii. (1883) 3 pls. (Danish with French resumé). See Bot. Centralbl., xv. (1883) p. 257. Cf. this Journal, ii. (1882) p. 234; iii. (1883) p. 232.

Hansen finds that some forms of *Torula* as well as of *Saccharomyces* can invert and also cause alcoholic fermentation; while others show the latter phenomenon only.

**Alcoholic Ferments.***—L. Bontroux employs as diagnostics of the species of fungus that induce fermentation the form of the vegetative cells, whether elongated or oval, whether they occur singly or in colonies, their fermenting activity, and their power of resisting acids and high temperatures. He describes as many as nineteen species of *Saccharomyces*, but some of them are forms of other fungi, as *Oidium lactis*, *Dematium*, &c.

**Magnin's 'Bacteria.'**†—The second edition of this book contains not only Cohn's accepted provisional classification of the Bacteria, but a general *resumé* of the latest labours in this difficult study, largely supplemented by the experimental observations of Dr. G. M. Sternberg, the translator. Scarcely any subject since the time of Jenner has attracted so much attention as the question of the proof of the infectiveness of certain of the bacteria. Opinions have fluctuated not only in connection with the difficulty of proof required, but also from the differences in the methods of experimenting. In some cases pure cultures have not been made use of, and in others the series of observations have not been of a sufficiently extended nature to determine correctness in the results. Dr. Sternberg is very critical in accepting some of the conclusions and statements made by others; and hence he has taken the precaution to lessen any objections that may be made against his own observations, which are therefore the more valuable and trustworthy. At the same time he avoids accepting the evidence where the subject is still under serious discussion. When the experiments are of a positive nature, as in the virulence of his own saliva when injected into rabbits, he does not hesitate to join the ranks of those who insist upon the *bacteria*, *bacilli*, or *micrococci* being the cause of the malady induced, and not the sepsin or septic product produced by the microrganism, as has been insisted upon by some.

The fuller our knowledge of the *rôle* these invisible organisms play, the greater the facility of establishing the laws of hygiene and the means, if not of eradicating our common enemies, yet of lessening the virulence. Whether we are to accept Zopf's views of all forms being originated by development from the same organism; whether the common forms by transmission through various living organisms, or certain media, in themselves harmless or hurtful, obtain, increase, or lose their virulence; whether by the slow progress of evolution gathered in their course and transmission through different species of living bodies, modified properties have been acquired either in a single or several species, and whether by a selected reversal of the mode of life a reversion to harmlessness can be induced in the virulent forms, are questions of serious import that lie in the future. To those interested in the question of germicides (sporocides) and antiseptics, we may refer to an article by Dr. Miquel,* the able observer at the Montsouris Observatory, Paris, who has largely extended the list, which is headed by biniodide of mercury.

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* Bull. Soc. Linn. Normandie, iii. (1883) 42 pp. See Bot. Centralbl., xv. (1883) p. 329.

† Magnin, Dr. A., 'Bacteria. Translated with additions by Dr. G. M. Sternberg, F.R.M.S.' 487 pp., 12 pls., and figs. 2nd ed., 8vo., New York, 1883.

Those who are in want of a subject for investigation may be strongly advised to cultivate an acquaintance with the pages of this valuable work, and add their own independent observations to the list of original articles of which there is a very copious bibliography brought down to a very late period. Dr. Sternberg can be congratulated on giving us a well illustrated and most readable addition to the literature of the bacteria with valuable information derived from his own careful experiments.

### Lichenes.

**Cephalodia of Lichens.†**—K. B. J. Forssell proposes to confine the term Cephalodia to those structures which contain one or more algæ, the type of which differs from the normal gonidia of lichens, and which have been formed by the mutual action of hyphæ and algæ. Cephalodia have been at present observed in one hundred species of algæ, but belonging to only a few genera. They appear to occur chiefly in the Archilichenes. Those described in other families have mostly not been properly cephalodia, where the hyphæ always obtain a stronger development from contact with the algæ; as *Peltigera canina*, where the hyphæ serve to nourish the algæ, or *Solorinella asteriscus*, where they are indifferent to one another.

The position of the cephalodia varies; they occur sometimes in the under, sometimes in the upper side of the thallus, sometimes on or in it; occasionally also in the protothallus. They usually form protuberances of a dark yellowish-red or dark red colour in the upper side of the thallus. When the cells of the algæ which form cephalodia come into contact with the hyphæ the hyphæ develope rapidly, involve the algal colony, and become copiously branched. The cells of the algæ divide at the same time, thus increasing the size of the cephalodium by mutual symbiosis. Most cephalodia are formed by the mutual action of algæ and of hyphæ which belong to an already developed lichen-thallus (cephalodia vera). Among these the author distinguishes between cephalodia epigena or perigena, formed on the upper side of, or upon, the thallus, as in *Peltidea aphtosa*, *Sphærophorus stereocauloides*, and *Stereocaulon ramulosum*; and cephalodia hypogena, formed on the under side of the thallus. There are differences again among these. Sometimes (*Solorina octospora*) the cephalodium lies at the base of the medullary layer; sometimes

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* 'La Semaine Médicale,' 30 Août, 1883.

† Bihang till K. Svenska Vet. Akad. Handl., viii. (1883) 112 pp. (2 pls.). See Bot. Centralbl., xv. (1883) p. 330.

(*S. saccata* and *Lobaria*) the alga penetrates into the medullary layer; or sometimes (*S. crocea* and *bispora*) it penetrates still higher into the thallus, and spreads into the yellowish-green gonidial layer, which is often replaced by it; or finally (*Lobaria amplissima*, *Lecanora gelida*, and *Lecidea panæola*) the gonidial and cortical layers are broken through, and the cephalodium emerges on the upper side of the thallus.

Under the name Pseudocephalodia (as distinguished from cephalodia vera) the author describes such as are formed in the protothallus by the germinating hyphæ investing algal colonies of some other type than the normal gonidia of the lichen. They are but slightly united with the other parts of the thallus, and exhibit a tendency towards independent development. At present they have been observed in only a few lichens:—*Solorina saccata* var. *spongiosa*, *Lecidea pallida*, and probably in *Lecanora hypnorum* and *Lecidea panæola*. Intermediate forms also occur between the various kinds of cephalodia.

In some of the above-named species the author states that the pseudocephalodia develope in the same way as is described by Schwendener from the thallus of lichens, a point of considerable importance with regard to the Schwendenerian theory of the origin of lichens. In the true cephalodia we have in fact a double parasitism, or mutual symbiosis of algæ and fungal hyphæ.

**Lichens from the Philippines.***—B. Stein describes a number of lichens forwarded by Dr. Schadenberg from Mindanao in the Philippines. Among them is a new genus, *Dumoulinia*, belonging to the Lecanoreæ, of which he gives the following diagnosis:—"Thallus crustaceus uniformis; apothecia lecanorina, superficialia, excipulo crasso cupulari; sporæ quaternæ, maximæ, hyalinæ, tetrablastæ."

### Algæ.

**Protoplasmic Continuity in the Florideæ.**†—T. Hick has made an extensive series of observations on a large number of species belonging to the more important genera of Florideæ, with special reference to the question of protoplasmic continuity. He finds in all the species examined that there is such a continuity, and that of the clearest and most definite character. In the simpler filamentous types, such as *Petrocelis cruenta* and *Callithamnion Rothii*, the protoplasm of each cell is united with the protoplasm of contiguous cells by means of a fine protoplasmic thread. This occurs throughout the whole plant. In the more complex types, such as *Callithamnion roseum*, *arbuscula*, and *tetragonum*, the arrangements for continuity are of a more elaborate character. The contents of the axial cells are not only united with one another, but also with those of the cortical cells, however numerous these may be. The cortical cells also display continuity *inter se*. *Ptilota elegans* is a most instructive form, as here the connective threads may be easily traced from the tips of the ultimate branchlets to the base of the stipes of the frond. As the threads become older, they increase in thickness, thus showing that they are not merely temporary or effete structures. On the stouter connecting-cords a sort of ring or collar is developed at about the middle point, and over this is stretched, in some cases, a delicate diaphragm. The behaviour of both rings and diaphragm, when treated with microchemical reagents, is similar to that of ordinary protoplasm.

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* JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 227-34.

† Proc. Brit. Assoc. Adv. Sci., 1883. Cf. Nature, xxix. (1883) p. 581.

**Distribution of Algæ in the Bay of Naples.**[*]—G. Berthold finds that if, in the algæ growing in the Bay of Naples, those species are separated the habitat of which is above low-water mark, and those which require strong currents, the great majority of the 180 to 200 species which remain are not confined to particular zones of depth. The species found in the zone between ebb and flow are usually peculiar to that habitat, or at all events do not thrive in greater depths. To this class belong *Bangia*, *Nemaleon*, and *Gelidium crinale*. Some species thrive best in strong currents; *Corallina* is especially partial to the zone of breakers. Stagnation of the water greatly diminishes the number of species; and some, in consequence, are entirely wanting at considerable depths. The presence of diffused light in the water is extremely important for the life of algæ; the minimum intensity at which they can thrive lies at but a small depth below the surface. Those species which grow in shady places, like marine grottoes, are in general found only near their entrances. The Florideæ are found especially where the light is diffused, the greater number of brown algæ, with a few Florideæ and Chlorosporeæ, in localities exposed to the direct light of the sun.

**Algæ of Bohemia.**[†]—A. Hansgirg gives a detailed account of the algæ of Bohemia, with reference both to their classification and their biology. The mode of life of *Leptothrix rigidula* Kütz. is especially described in detail.

**Fossil Alga.**[‡]—Under the name *Bythotrephis devonica*, C. J. Andrä describes a new alga, the remains of which he finds in the "Hunsrückschiefer," belonging to the Devonian formation.

**New Genera of Algæ.**[§]—A. Borzì describes several new genera of algæ, as under, viz.:—

*Leptosira.*—The only species, *L. Mediciana*, occurs among cultures of fresh-water algæ from bogs on Etna. It forms minute rounded green tufts composed of a number of dichotomously branched arms. The cells are oblong, and with very delicate cell-wall. All the cells can become zoosporangia. They swell into a spherical form, and the numerous zoospores escape through a hole in the side of the mother-cell. They are at first all inclosed in a common envelope, which soon dissolves in water. They are small, biciliated, and provided with an eye-spot. They conjugate, but in a manner different from other algæ, uniting by the end which does not bear the cilia. The zygospore becomes invested, in the course of a few days, with a cell-wall; the further development of the resting-spore was not observed. Those zoospores which do not conjugate, develope asexually in the ordinary way. After a time the terminal cell of the filament breaks up into from four to eight cells, which become detached, and present a protococcoid appearance. They develope, on germinating, into the original tufts, each cell putting out from two to four germinating filaments. He proposes to place this genus in his new class of Chroolepidaceæ (see p. 106).

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[*] MT. Zool. Station Neapel, iii. (1882) pp. 393–536 (3 pls.).

[†] SB. Böhm. Gesell. Wissensch., 1883. See Bot. Centralbl., xvi. (1883) p. 33.

[‡] Verhandl. Naturh. Ver. Preuss. Rheinlande u. Westfalen, ix. (1882) pp. 110-3.

[§] Borzì, A., 'Studi Algologici,' 117 pp. (9 pls.) Messina, 1883. See Bot. Centralbl., xvi. (1883) pp. 66–75.

*Ctenocladus.*—The only species, C. *circinnatus*, forms green incrustations in brackish marshes, composed of densely crowded tufts. The prostrate, curved, and segmented filaments put out a number of short segmented branches, which are all beautifully curved. These branches again branch, but the branches are borne on one side only. The cells contain homogeneous chlorophyll, a starch-grain, and a true nucleus; the wall is divided into three layers, the outermost of which presents the reactions of cuticle. Asexual reproduction takes place by means of macrozoospores and microzoospores. The macrosporangia are very elongated cells in the branches, or sometimes cells which put out a long lateral protuberance. The zoospores, from four to thirty-two in number, are forced out through a narrow opening in the wall of the mother-cell. They have the ordinary form of biciliated zoospores, and germinate into the new tufts after swarming for about twelve hours. After the discharge of the macrospores the thallus assumes a hibernating condition. The cells become rounded off, many of them divide, and the common cell-wall is gradually absorbed, so that the tuft becomes changed into an irregular aggregation of cells imbedded in mucilage, a protococcoid colony resembling a *Palmella* or *Glœocystis*. These palmelloid cells produce the microzoospores, from four to sixteen in a cell. They resemble the macrozoospores, except in size; their behaviour on germination was not observed. Sometimes the hibernating cells which do not give birth to microzoospores enter on a new condition; they develope into filaments closely resembling a *Ulothrix*, which form a kind of hypothallus. In these, shorter dark green cells are formed which develope into the typical tufts of *Ctenocladus*. But while these tufts mostly pass over in autumn into the hibernating condition already described, some cells, which Borzì calls "zoogonangia," enlarge greatly, assume a pear-like form, and hibernate in this condition. From these are produced in the spring biciliated zoospores, which conjugate; but conjugation takes place only between zoospores from different zoogonangia. The author considers the genus as probably a highly specialized form of the Chroolepidaceæ.

*Physocytium.*—The only species, *P. confervicola*, was found growing on *Œdogonium* and *Cladophora*. It forms small colonies attached to the substratum by a delicate filament. Each colony is composed of from 1 to 32 ciliated cells inclosed in a vesicle of very fluid mucilage, in which they swarm actively; each vesicle is attached to the substratum by two very delicate threads. Each cell has two cilia, abundant cellulose, a starch-grain, red eye-spot, and two alternately pulsating vacuoles. After a time the vesicle bursts; the cells swarm free, then become immotile, and enter into a palmella-condition, a number being inclosed in a common gelatinous envelope. They divide, like *Palmella*, and each cell ultimately developes into a microzoospore, closely resembling one of the original cells. Several alternate generations of zoospores and palmella-cells are produced in the autumn and winter, and in the spring commences the sexual reproduction. Some of the palmella-cells are transformed into zoogonangia; out of the contents of each of these are formed from 4 to 16 zoogonidia, scarcely differing from the zoospores, but possessing sexual properties, since some of them conjugate, the rest soon perishing. The zygospores contain a red endochrome, and remain dormant for a time. In the latter part of the summer they germinate, and each produces one or less often two macrozoospores, which ultimately attach themselves to another alga, become invested with an envelope of mucilage, and develope, by the division of their contents, the original colonies. The author considers the genus nearly allied to the Volvocineæ.

*Kentrosphæra.*—Two species of this genus form green gelatinous lumps in the midst of filaments of Oscillarieæ. These colonies are composed of zoosporangia; each sporangium is unicellular, about 200 $\mu$ in diameter, with a very thick concentrically stratified wall of cellulose, and often possessing on one side a protruding spur. The cell contains bands of chlorophyll and a red pigment; the bands disappear, the cell becomes uniformly green, and the contents break up into a great number (about 400) of zoospores; they are minute and biciliated, but possess no vacuole or eye-spot. After swarming they become fixed, and develope into spherical cells, which divide internally into the protococcoid colony. Many of these colonies may follow one another in succession. No sexual mode of propagation is known. *Kentrosphæra* probably belongs to the Palmellaceæ.

*Hormotila.*—*H. mucigena*, the only species, covers with a thick green incrustation the walls of water-basins and damp rocks round Messina. Its vegetative form is scarcely distinguishable from a *Glœocystis;* the cells, very unequal in form and size, are imbedded in mucilage. Reproduction takes place only by means of zoospores, and apparently at all times of the year. To form zoosporangia, certain of the cells separate from the rest, and lose their mucilaginous envelope. These divide repeatedly by bipartition, and thus form small branched tufts bearing an external resemblance to *Cladophora*. In each of these cells are formed from 8 to 64 minute biciliated zoospores, which escape through the lateral protuberance in the wall of the mother-cell. After swarming they either develope directly similar tufts of sporangia, or, more often, pass through the glœocystis-condition first. The genus must be regarded as belonging to the Palmellaceæ.

**Polymorphism of the Phycochromaceæ.***—W. Zopf details the structure and development of a low algal form which he calls *Tolypothrix amphibia*, and which he regards as confirming his view already published as to the genetic connection of low forms of fungi. It was found among the protonema of a moss, and had two forms, an aquatic form, and an aerial form growing on the surface of water. The aquatic form is filiform, and closely allied to the organisms which make up the genus *Tolypothrix*. It consists of an unbranched filament of cells inclosed in an evident sheath; within this sheath it breaks up into fragments or hormogonia. The aerial or chroococcus form developes from hormogonia, consisting of three or more cells which reach the surface of the water. Here a number collect together, and their extremely thin gelatinous envelope coalesces together into a continuous oily membrane. The blue-green colour of the hormogonia has now passed over into a greener tint. In this condition the cells divide in all three directions, and not in one only, as had previously been thought to be exclusively the case with the Scytonemeæ.

**Reproduction of Ulva.**†—A. Borzì thus describes the development and conjugation of the zoospores of *Ulva Lactuca*, which takes place freely in cultivation. The zoospores are oval, and are provided on the anterior beak with two colourless cilia, and, attaching themselves to one another by their anterior ends, coalesce in the course of about five minutes into a swarm-spore twice as large with four cilia. Occasionally the position of one of the conjugating swarm-spores is reversed. Compared with the great number of swarm-spores, conjugation takes place very rarely, which may be the result of a sexual differentiation, although none is visible externally; there is no difference in their motility. Warmth influences favourably their emission and motility. But it is interesting that while the ordinary zoospores display distinct positive heliotropism, the zygospores acquire an opposite heliophobic tendency, in consequence of which they seek dark spots, where their further development may proceed.

The zygospores lose their cilia and coalesce completely into an oval body, in which the anterior end is still distinguished by the absence of endochrome, while the other end has a great quantity of chlorophyll and the two pigment-spots and starch-grains of the two original zoospores. The zygospore attaches itself by its anterior end, and, after growing rapidly, divides transversely. The basal and apical cells finally become completely separated, this being preceded by the apical cell becoming narrowed and prolonged at the base into a beak-like colourless appendage. Similar transverse divisions follow, and thus a small colony is formed of unicellular individuals closely associated together, and constituting an asexual generation. Each of these individuals developes into a new frond; first of all becoming attached by its colourless end, and then dividing first into a filament and then into a plate of cells.

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* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 319-24 (1 pl.). Cf. this Journal, iii. (1883) p. 688.

† Borzì, A., 'Studi Algologici,' 117 pp. (9 pls.) Messina, 1883.

**Relationship between Cladophora and Rhizoclonium.***—A. Borzì considers that many algæ hitherto considered as belonging to the Confervaceæ are not independent forms, but stages of development of species of *Cladophora*. This applies especially to several species of *Rhizoclonium*, which he has, in cultivation, developed into filaments of *Cladophora*; thus confirming the previous hypothesis of Schmitz. *Gongrosira pygmæa* he also shows to be a form of *Cladophora fracta*.

The multinucleated condition of the cells, so common in the Siphonocladiaceæ, Borzì regards as simply the result of imperfect septation.

**Classification of Confervoideæ.**†—A. Borzì proposes the new family Chroolepidaceæ, to include his new genus *Leptosira* (see p. 102) along with *Trentepohlia*, *Acroblaste*, *Chlorotylium*, *Microthamnion*, and *Pilinia*; which he separates from the Confervaceæ, and gives the following classification of the Isogamous Confervoideæ:—

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|---|---|
| Segment-cells with several nuclei. | |
| Thallus unicellular. | Fam. 1. Siphonaceæ. |
| Thallus multicellular. | Fam. 2. Siphonocladiaceæ. |
| Segment-cells with a single nucleus. | |
| Thallus of a single lamella. | Fam. 3. Ulvaceæ. |
| Thallus filamentous. | |
| Chlorophyll parietal; zoosporangia not distinguishable from the vegetative cells. | Fam. 4. Ulotrichaceæ (incl. Chætophoraceæ). |
| Chlorophyll diffuse; zoosporangia distinguishable from the vegetative cells. | Fam. 5. Chroolepidaceæ. |

**Action of Tannin on Fresh-water Algæ.**‡—J. B. Schnetzler had previously demonstrated the presence of an appreciable amount of tannin in fresh-water algæ, *Vaucheria*, *Spirogyra*, *Conferva*, &c. If the alcoholic solution of the chlorophyll of these algæ is treated with sulphate of sesquioxide of iron, an abundant blue precipitate takes place. If the entire fresh vigorous algæ are immersed in a solution of this salt of iron, they remain green for a considerable time, the cells becoming a dark blue only after the death of the protoplasm. The cells of *Spirogyra* seem to display great variation in their tenacity for life. In a green filament certain cells, either adjoining or separated, may be seen to become dark blue under the influence of the iron-salt. The position of these cells shows that their taking this colour cannot be due to external causes, but to their individual peculiarities, to the degree of resistance which the living protoplasm offers to the action of the iron-salt. After a time, when the protoplasm of all the cells is dead, the whole filament is coloured dark blue. Tannin appears therefore to be here an essential ingredient of living protoplasm.

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* Loc. cit.
† Loc. cit.
‡ Bot. Centralbl., xvi. (1883) pp. 157-8.

**New Species of Bulbochæte.**[*]—O. Nordstedt describes two new species of this genus. The first, from Brazil, was sterile; but is distinguished from all known species by a whorl of spines in the middle of each cell except the basal and all the hair-cells. The other species is from Australia, where it grows attached to Characeæ. It is allied to *B. minor*, but is characterized by peculiar dwarf males. The terminal cells of these dwarf males bear a bristle; and the antheridium is also sometimes divided into two branches. It constitutes therefore an intermediate form between those with unbranched dwarf males destitute of bristle, and the ordinary large branched, bristle-bearing plants, the antheridium of which is never branched.

**New Genus of Oscillarieæ.**[†]—Under the name *Borzia trilocularis* F. Cohn describes a new oscillarian alga exhibiting a structure altogether parallel to *Bacterium*. It forms olive-brown masses in fresh water inhabited by *Œdogonium* and other algæ. It consists of short oblong rods which oscillate slowly and with difficulty, each composed of three cells filled with granular phycochrome, the two terminal cells being rounded off. By cell-division the number of cells increases to six, and each rod then divides into two. In the neighbourhood of Breslau it shows no disposition to assume a filamentous or any other condition.

**Vaucheriæ of Montevideo.**[‡]—J. Arechavaleta has studied the species of *Vaucheria* found near Montevideo, of which he gives a detailed description, with diagnosis of eight new species. Some of these appear, however, to be identical with well-known European species; and of others the description given is deficient in some points necessary to determine whether they must be regarded as good species.

**Gongrosira.**[§]—N. Wille, who has found *Gongrosira de Baryana* Rab., growing on *Planorbis* and *Paludina*, has proved, by cultivation, that it is a form of *Trentepohlia* Mart. (*Chroolepus* Ag.). The bra·ching resembles at first that of *Coleochæte irregularis* or *Trentepohlia umbrina*, forming a disk of cells from which the branches rise. In each cell is only one nucleus; the chlorophyll is parietal; sometimes a few drops of oil occur in the centre of the cell. The cell-wall is thick and evidently laminated, and readily becomes mucilaginous. Swarm-spores are formed in terminal sporangia, resembling those of *Trentepohlia*. No conjugation was observed, nor was the further development of the spores followed out. Propagation takes place by single cells becoming detached from the vertical branches, and developing directly into new plants.

The organs described by Rabenhorst as oogonia the author believes to be resting-cells similar to those of *Conferva pachyderma*. The immotile reproductive cells, which are formed directly without any true process of cell-formation, he calls "akinetes"; while to those formed asexually by true cell-formation he gives the term "aplanospores"; they germinate directly, or after a period of rest. Under cultivation *Trentepohlia umbrina* may become quite green.

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[*] SB. Phytograph. Gesell. Lund., May 28, 1883. See Bot. Centralbl., xvi. (1883) p. 95.

[†] JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 226–7.

[‡] Anal. Aten. del Uruguay, iv. (1883) p. 18 (2 pls.). See Bot. Ztg., xli. (1883) p. 627.

[§] Ofvers. K. Svensk. Vetensk. Akad. Förhandl., 1883, pp. 5-20 (1 pl.). See Bot. Centralbl., xvi. (1883) p. 162.

Other species of the pseudo-genus *Gongrosira*, Wille refers as conditions of species belonging to different genera as follows:—*G. dichotoma* Kütz., is a peculiar aplanospore condition of *Vaucheria geminata* Walz.; *G. clavata* Kütz. is the sporiferous vegetative plant of *Botrydium granulatum*; *G. ericetorum* Kütz. is the protonema of a moss; *G. ericetorum* v. *subsimplex* Rab. is probably a *Ulothrix* or *Conferva*; *G. pygmæa* probably a *Stigeoclonium*; *G. Sclerococcus* Kütz. (*Stereococcus viridis* Kütz.) may be a *Trentepohlia*; *G. protogenita* Kütz. is probably the palmella-form of a *Stigeoclonium*; Reinsch's species cannot be determined; *G. onusta* Zell. comes near *Trentepohlia de Baryana*.

**Phyllosiphon Arisari.**[*]—M. Franke finds this parasitic alga abundantly on the leaves of *Arisarum vulgare* in the neighbourhood of Messina, and elsewhere in Sicily and Calabria; but it appears never to attack *A. italicum*. The spores are capable of germinating at any period of the year, but must go through a period of rest; the larger spores appear to divide into several. They always attack their host by penetrating the epidermis between two cells, which they force apart by their germinating filament. The restricted conditions necessary for the germination of the spores greatly diminish its destructive effects.

**Occurrence of Crystals of Gypsum in the Desmidieæ.**[†] — The occurrence of crystals of calcium sulphate, endowed with a peculiar "dancing" motion, has long been known in the terminal vesicles of *Closterium* and in other desmids; the phenomenon has now been carefully investigated by A. Fischer. Their chemical constitution was clearly established by different tests. They are always quite isolated from one another, and occur in all parts of the cells, though in the greatest quantity in the terminal vesicles; they are either carried along passively by the currents of protoplasm, or they "swarm" in the space filled with cell-sap between the cell-wall and the radiating chlorophyll-bodies; these vesicles are not true vacuoles, but portions of the cell-sap space. The crystals are not formed, nor do they grow, in this vesicle, but reach it in a mature condition from some other part of the cell, being formed apparently in the furrows between the bands of the chlorophyll-bodies; from here they are carried to the terminal chambers by the protoplasmic currents.

Fischer found these crystals in all the species of *Closterium* which he examined; also in various species of *Cosmarium* (though individuals are often entirely destitute of them), their form being the same as in *Closterium*. They occur also in *Micrasterias*, *Euastrum*, in which genera also they are not invariably present, and always in *Pleurotænium*, *Penium*, and *Tetmemorus*, but were absent from all the specimens examined of *Staurastrum*, *Desmidium*, and *Hyalotheca*. They appear to be entirely confined to the Desmidieæ, other fresh-water algæ containing calcium oxalate, especially species of *Spirogyra*, but not calcium sulphate.

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[*] JB. Schles. Gesell. Vaterl. Cult., 1883, pp. 195–7. Cf. this Journal, ii. (1879) p. 606; ii. (1882) p. 391; iii. (1883) p. 108.

[†] Pringsheim's Jahrb. f. Wiss. Bot., xiv. (1883) pp. 133–84 (2 pls.).

The absence of crystals of calcium sulphate, either occasionally or regularly, does not, in the opinion of the author, imply the absence of the salt; since, from its solubility in water, it may be present in the cell-sap. The zygospores of *Closterium* were always found to contain crystals. Calcium sulphate is an excretory product in the process of metastasis, corresponding to the production of calcium oxalate in the higher plants; and the quantity excreted determines whether it shall remain entirely dissolved in the cell-sap, or whether a portion of it shall separate in the form of crystals.

◆

## MICROSCOPY.

### a. Instruments, Accessories, &c.

**"Giant Electric Microscope."**—One of the attractions at the Crystal Palace is what is advertised as "Les Invisibles in the Giant Electric Microscope." We take the following description from a daily paper,* no other description being forthcoming. "A number of gentlemen assembled at the exhibition court of the Crystal Palace on Saturday, by invitation of the directors, to witness the first representation in England of 'Les Invisibles,' an exhibition of natural objects magnified and displayed by means of the great electric Microscope. The apparatus used in the exhibition is the invention of Messrs. Bauer and Co., and 'Les Invisibles' has quite recently attracted a good many visitors to the old Comédie Parisienne, where, as well as at the Athenæum at Nice, a series of representations has been given. The invention may be described in a few words as being the application of electric light to the Microscope, and the result, so far as the spectacle is concerned, is a sort of improved and enlarged magic lantern. Every one is familiar with the former exhibitions at the Polytechnic and elsewhere of the animalculæ (*sic*) in a drop of water, magnified and thrown, by the aid of the lime-light, on to a white screen. Precisely the same sort of effect was produced on Saturday by Mr. F. Link, the London agent for Messrs. Bauer and Co., with this difference, that the magnifying power was enormously in excess of that attained in the old magic lantern entertainments. The electric Microscope has, in fact, made it possible to exhibit in a most attractive form, the appearances presented by minute natural objects when placed under the most powerful magnifying glass. Indeed, the difficulty with which Mr. Link had to contend on

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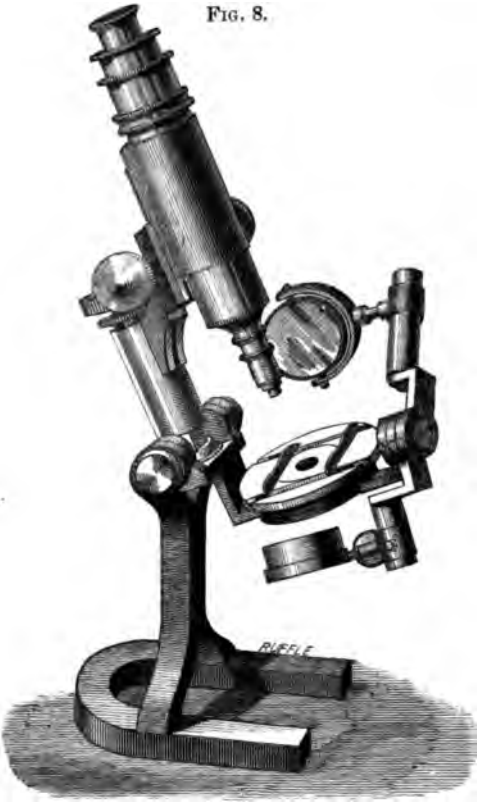
* 'Morning Post,' 5th Jan., 1884.

Saturday was the smallness of the screen upon which his pictures were thrown. For instance, only a small section of a butterfly's wing could be shown at a time, although the screen was as large as the size of the entertainment court would permit, whilst the living organisms in a spot of water and the mites in a small piece of cheese were enlarged until they presented a perfectly appalling spectacle to a timid mind. The capabilities of the apparatus may be imagined from the fact that the eye of a fly was presented in a form no less than four million times its natural size. The electric Microscope, which is worked by an ordinary primary battery, may be said to have extended almost indefinitely the possibilities of presenting in an attractive and instructive manner the wonderful facts of natural science."

**Aylward's Rotating and Swinging Tail-piece Microscope.**—Mr. H. P. Aylward has added a new movement to the radial swinging

FIG. 8.



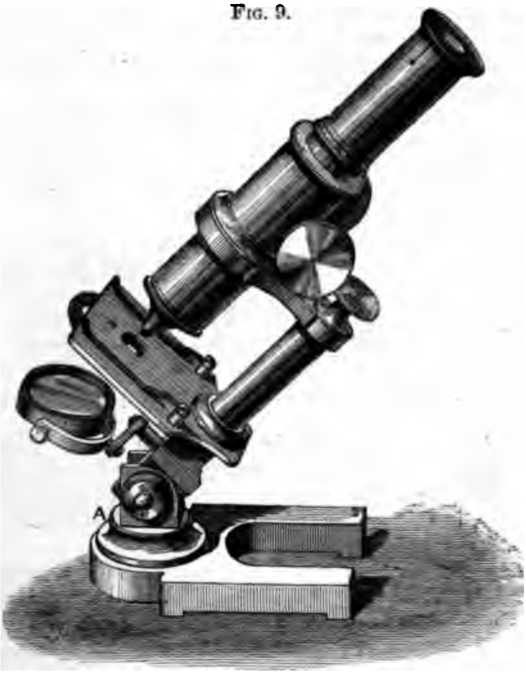
tail-piece. Not only do the mirror and the substage swing on separate tail-pieces, either above or below the stage, but they can also be rotated completely round the stage, so that the direction of the illumination in azimuth can be more readily varied than is the case with Zentmayer's form of tail-piece.

The stage consists of a fixed ring attached to the limb by an angle-plate of brass; this ring carries above it the rotating object-stage, and beneath a rotating collar is fitted, which has a shoulder attachment at right angles carrying the two tail-pieces on an axis slightly above the plane of the object-stage, and allowing of their rotation round the optic axis. The angle-plate, by which the stage-ring is fixed to the limb, is so arranged that the shoulder carrying the tail-pieces will pass behind it, and there is therefore no obstruction to complete rotation.

This plan of suspending the tail-pieces is far more convenient than that devised by L. Jaubert,[*] or that of J. Mackenzie.[†]

**McLaren's Microscope with Rotating Foot.**—Mr. A. McLaren has devised a simple plan of giving greater stability to Microscopes mounted on a pillar support on a horse-shoe foot, which are very liable to be overturned when much inclined from the perpendicular. The plan consists in making the foot rotate at its junction (fig. 9, A)

FIG. 9.



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[*] See this Journal, i. (1881) pp. 514–5.

[†] Ibid., pp. 825–7.

with the pillar support, so that when the Microscope is required to be used much inclined the horse-shoe base can be turned round as shown in the fig. This increases the stability of the Microscope, and adds so little to the original cost that the makers of these inexpensive forms may profitably adopt the suggestion.

Mr. McLaren also uses a system of fine adjustment applied at the nose-piece (shown in the fig.), consisting of a ring fitting in the lower end of the body-tube, in which the nose-piece proper, carrying the objective, is screwed by means of a very fine screw, 200 threads to the inch. The focusing is effected by turning the nose-piece either way, by which the objective is raised or depressed very slowly owing to the fine pitch of the screw. By this system, which is also applied to some old forms in our possession, the objective is made to rotate with every movement of focusing, which cannot be commended.

**Schieck's Revolver School and Drawing-room Microscope.—Winter's and Harris's Revolver Microscopes.**—F. W. Schieck has just issued the Microscope shown in fig. 10 A and B, intended for school and drawing-room demonstration. The peculiarities of the instrument are fully set forth by Herr Schieck himself in the following statement (translated), which also includes some very original directions for preparing objects:—

"The management of a Microscope of the ordinary construction, with fixed stage, movable tube, different eye-pieces, objectives, &c., offers, in most cases, so many kinds of difficulties to the lay public, especially to young students, in the inspection of the preparations accompanying the Microscope, and in the adjustment of the image, but especially in the self-preparation of objects, that this important and interesting instrument has not yet attained that position either among our intelligent youth, or in our drawing-rooms, as an object of instructive entertainment, which befits its high ethical importance. The management of the Microscope has even been found so intricate, that in consequence (as I have had the opportunity of seeing on numberless occasions) it has been very soon put aside again, after a short trial.

My new Microscope entirely removes this disadvantage. It is of such simple construction, and its management so thoroughly easy, that any one, even without any previous acquaintance with the use of a Microscope, is able to observe with it, as well as to make for himself beautiful microscopical preparations.

The new Revolver Microscope has, instead of a stage, a vertical drum, turning on its axis (like the chambers of a revolver), in which twenty different very beautiful and instructive preparations, from the three natural kingdoms, are arranged, which, on turning the drum, are brought successively into the field of view of the Microscope. The movable mirror is in the centre of the drum, and is easily and conveniently adjusted.

The Microscope is provided with a hinge for inclining the stand, so as to be able to observe conveniently whilst sitting.

The twenty preparations are numbered, and an explanation of them accompanies each Microscope.

As the Microscope has only one objective, and one eye-piece, and therefore only admits of a fixed magnifying power, a special focusing arrangement is not necessary. The tube of the Microscope is so fixed, that the image of the preparation is always in the field of view of the eye-piece, and only in the case of differences in the eyes of observers is a small shifting of the tube, amounting to a few millimetres, requisite. For this purpose the body-tube is easily pushed with the hand up or down, guided by a pin working in the small slit in its sheath, without ever thereby losing sight of the image of the preparation, as happens with other Microscopes.

Fig. 10 A.

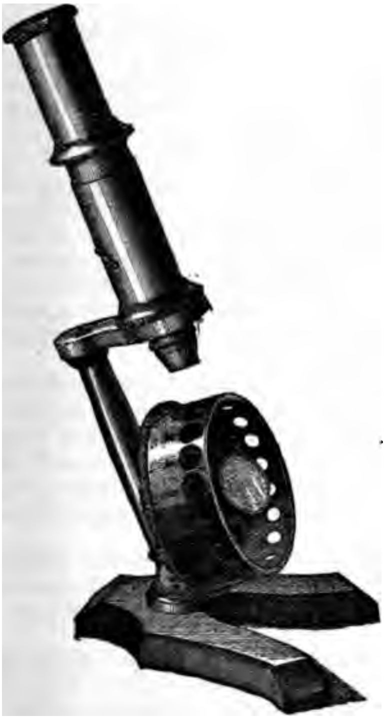
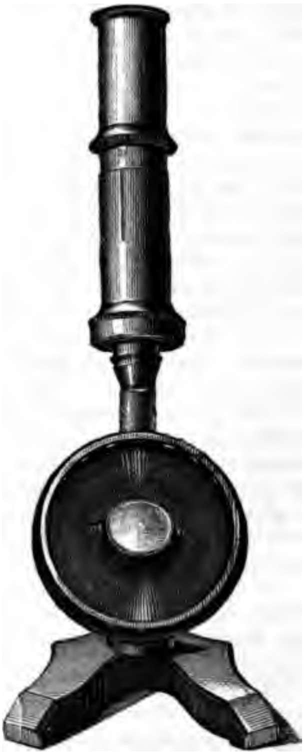


Fig. 10 B.



The magnifying power is such that most popular objects can be seen distinctly and perfectly. The images are of unsurpassed sharpness and clearness.

The field of view is very large, and all preparations which are not more than 4 mm. in diameter can be seen entire at one view.

An entirely special advantage of this new Microscope is the uncommonly simple manner in which the teacher or student is enabled by its means to prepare by himself a new series of twenty preparations at pleasure. The hitherto general practice of laying the object to be inspected on large glass slides, and fastening over them the thin, round or square, cover-glasses, presented so many difficulties that a preparation seldom succeeded well, especially if it were put up for any length of time.

With each of my new revolver Microscopes is given a second stage-drum, with twenty empty apertures, and a sufficient number of small round glasses and spring-rings for firmly fixing the preparations. The stage-drum with the preparations already attached to the Microscope is unscrewed from the milled disk, and the second empty drum put in its place.

The insertion of a new object is so exceedingly simple, that directions for it seem, properly speaking, superfluous. In the first place a small round glass is washed clean, and with the forceps belonging to the Microscope, is laid in one of the apertures, then the object to be examined is laid in the middle of this glass, either dry or with mounting liquid (glycerine, gelatine, Canada balsam, or in cases where only a rapid observation of an object is required, even water, spirit, &c.), and covered with a second previously cleaned glass, fastened down with a spring-ring which goes into a small groove made for it, and the preparation is ready. (!) It must, however, be here observed that all hard objects (especially insects) must, in order to succeed well, be previously heated for a few seconds in a small reagent glass, with caustic potash over a spirit flame, by which means the preparations become soft and quite transparent.

The preparations are perfectly protected from dust by a pasteboard cover, and care must be taken always to replace the cover over the stage-drum, after using the Microscope. If, in spite of this, dust should after a time fall upon the preparations, it must be carefully brushed away from both sides by the soft hair brush accompanying each Microscope; any other cleaning of the preparations is never necessary.

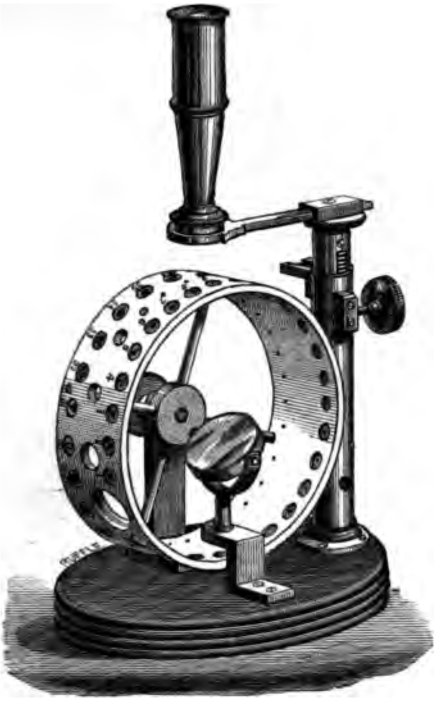
If desired these Microscopes can be supplied with special objects previously given me to prepare, and for the requirements of schools the stage-drum can be fitted with botanical, zoological, or mineralogical preparations. Price according to agreement.

This entirely new, and in every respect original and practical Microscope offers to every one such a fund of entertaining and instructive matter, and will prove to the teacher as well as the student such an inexhaustible source of suggestive occupation, by which to pass the leisure hours usefully and pleasantly, that there is scarcely anything better fitted for a present, always gladly seen, especially by the ripening student. The price is fixed as low as possible, and considering the prices ruling here may be called very cheap."

Herr Schieck intended, we have no doubt, to be strictly accurate when he announced his instrument as "entirely new" (*ganz neu*) and "in every respect original." But it was in fact anticipated by two now in Mr. Crisp's collection, which were made more than fifty years ago, by T. Winter (simple) and Harris and Son (compound, fig. 11).

They are in principle identical with that of Schieck. The revolving object-holder is, however, made of ivory, and is much larger, being 4½ in. in diameter and 1½ in. wide. There is also a double row of apertures for the objects—one row for transparent, and the other for opaque—so that, instead of 20, it holds 44 objects. There is also at one point of the circumference an intermediate set of apertures, apparently for inserting further objects on disks, corks, &c. (In Winter's there is a complete row of 19 of these apertures, 10 with corks).

FIG. 11.



**Winkel's Large Drawing Apparatus.*** — This (fig. 12) is intended for drawing objects under a low power, and also without any magnification. On the side of the standard A, and above the stage T and mirror S, is a cross-arm B carrying a lens L, and over it a small right-angled prism P, which acts as a camera.† On the other side there is a longer arm, also with a prism for drawing objects in natural size. The arms can be raised and lowered by the sliding within A of the support to which they are attached, the screw on the right clamping it.

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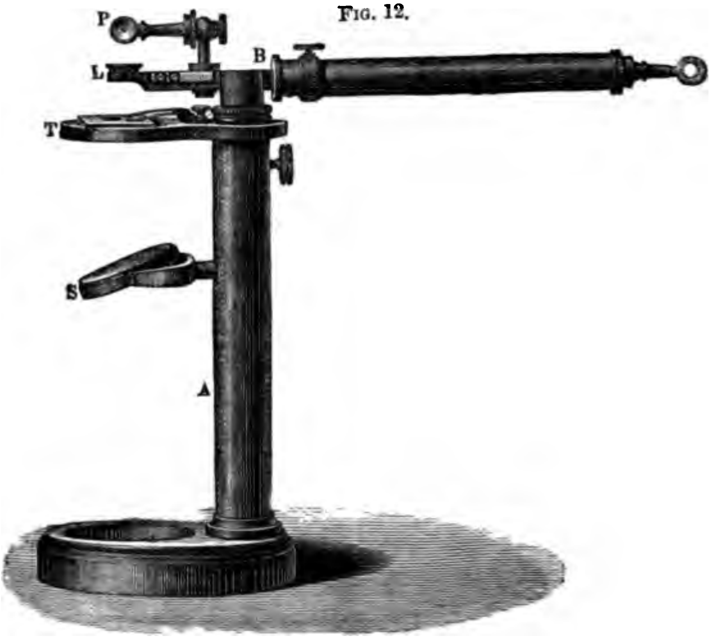
* Dippel's 'Das Mikroskop,' 1882, pp. 632–3 (1 fig.).

† The text states P to be a prism (protected by a ring) though the fig. hardly agrees.

FIG. 12.



**Jung's New Drawing Apparatus (Embryograph) for Low Powers.***—H. Jung was induced, by the inconvenient or ineffective performance of other drawing apparatus, to construct a new one (fig. 13) in accordance with the friendly advice of Professor v. Koch, giving powers of about 1 to 20 or 4 to 30 in continuous succession.

Upon the heavy square iron foot rests (besides the column and the bar P, movable by rack and pinion) a concave mirror to illuminate transparent objects. The latter is 80 mm. in diameter, and consists of a plano-convex lens silvered at the back. It is supported on a hinge-joint, which is attached to a short rod fitting into a spring-tube *h*, and this is screwed to a carrier T having a longitudinal slot. The carrier rests on the foot to insure greater stability, and on loosening the screw S which clamps it, it can be moved so as to obtain any desired position of the mirror, either by turning it round the screw as a pivot, or by sliding it along the slot.

Upon the column is a stage 75 mm. deep, and 108 mm. wide. The stage, instead of a round aperture in the centre has a horseshoe aperture 40 mm. wide, which can be wholly or partially covered by two sliding plates.

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* Zeitschr. f. Instrumentenk., iii. (1883) pp. 165–7 (2 figs.).

A special Brücke magnifier (with variable power) screws on the arm M. The arm has also a spring-tube into which a smaller mirror can be inserted. This is for illuminating opaque objects, and receives its light from the larger mirror below. The focus of both mirrors is so regulated that with high powers the theoretically possible maximum of illumination can always be nearly attained. For very weak illumination there is on one side a plate of opal glass. "The mirror has the great advantage over ordinary illuminating lenses that the field of view is always somewhat faintly and evenly illuminated, which extraordinarily facilitates the visibility of many natural objects which have not sharp outlines." The upper mirror can be placed in any position with regard to the axis of the lower, and can besides, for special objects, be put in the spring-tube of the lower mirror.

FIG. 13.

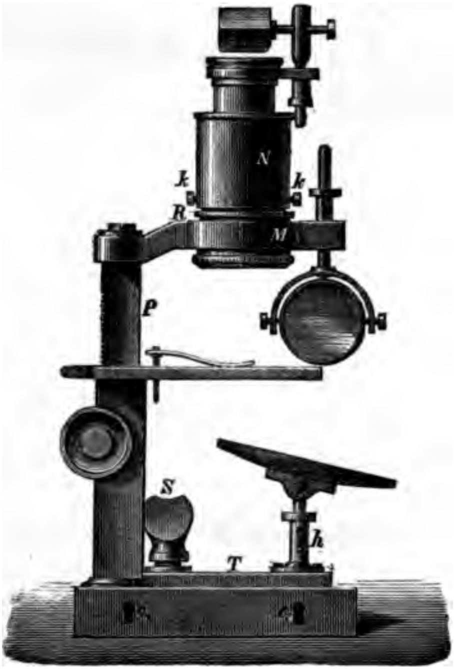
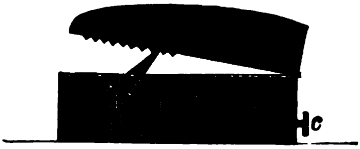


FIG. 14.

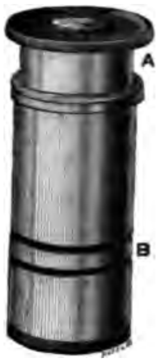


The Brücke lens consists of two achromatic objective lenses and a concave eye-lens. The objective lenses can be moved apart or brought nearer to one another by turning the ring R. In the same way the eye-lens can be placed at various distances from the objective by pushing the tube N up or down. This tube is so sprung in the inner fastening that by a somewhat firm pressing together of the two knobs *k*, the friction of the two tubes is lessened and an easy and smooth movement is obtained. For very low powers the lower objective lens can be removed. By this combination and also two stronger eye-pieces all gradations of power, in the given limits, can be obtained. The extent of the field of view is in inverse ratio to the power within the limits of 65 to 7 mm.

For convenient drawing a camera lucida is attached, which like Zeiss's allows the drawing surface to be inclined about 22° to the table. On turning the ring R, or on moving the tube to alter the power the camera always remains in the same position with regard to the ocular and the drawing surface, which is claimed to be "an advantage not to be undervalued, and not considered in many instruments."

In order to use the instrument for dissecting there are hand-rests, made to be easily removed. They consist of two hollow boxes (fig. 14) about 2/3 the height of the stage. They are attached by the button-headed screws *c* to the foot of the instrument, being inserted in the holes $c_1$ and $c_2$ (fig. 13) and the hinged tops can be set at different inclinations by the support and rack.

Fig. 15.



**Zeiss's Micrometer Eye-piece.**—This (fig. 15) is noticeable for the manner in which the micrometer disk is inserted. The eye-piece divides a little below the middle of its length, and has an additional piece between the upper and lower portions to which they are screwed. In this the micrometer disk is placed. The eye-lens is also in a sliding tube for adjustment to different sights.

**Bulloch's Objective Attachment.**—Mr. W. H. Bulloch has devised the objective-attachment shown in figs. 16 and 17. A is the nose-piece adapter to screw on the Microscope, and B is the ring, provided with three wedge-shaped studs, to be screwed on the objective. Three slots are cut in the body of the lower cylinder of the nose-piece A, and three similar slots in the inward projecting rim of a rotating collar. When the two sets of slots correspond, the ring B, with the objective attached, can be slid into the nose-piece, and then the studs are locked firmly by a slight turn of the rotating collar, which causes its projecting rim to slide over the outer halves of the studs. By reason of the wedge form given to the studs, the collar can be made to press down upon them with more or less force. The objective cannot be removed from the nose-piece until the rotating collar is turned back to the normal position, releasing the studs.

With this device both hands must be used either in attaching or removing the objective, and no provision is made to insure accuracy of centering. In the apparatus from which the above description was made the objective had a lateral play at the shoulder of about 1/50 in. when the collar was secured with moderate force. Such loose fitting would be found very inconvenient in the registration of the positions of small objects with high powers. Altogether, we cannot but think that the apparatus is more complicated than is at all necessary. Whilst it has the studs of Nelson's form it lacks the simplicity of the turn of the objective with the same hand that holds it, and whilst it has the rotating collar of the Watson-Matthews form (amply sufficient to hold the objective) it has the additional complication of studs in place of a simple conical fitting.

FIG. 16.

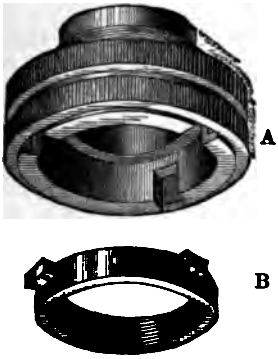
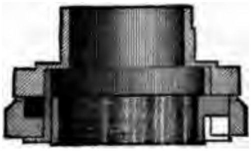
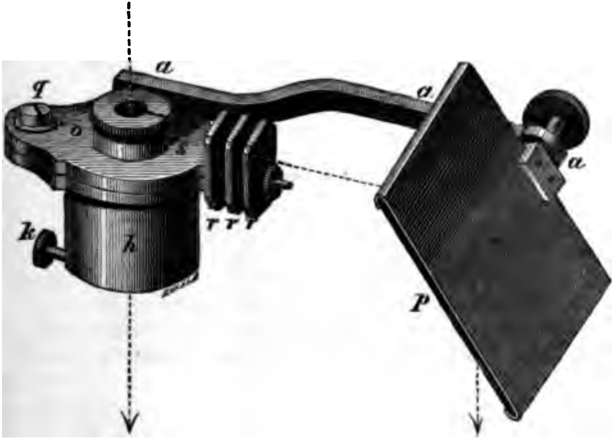


FIG. 17.



**Abbe's Camera Lucida.***—G. Kohl gives the annexed fig., 18, of what he terms "Boecker's new drawing apparatus after Dippel," but which is in reality Professor Abbe's Camera Lucida.†

FIG. 18.



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* Bot. Centralbl., xvi. (1883) pp. 385–6 (1 fig.).

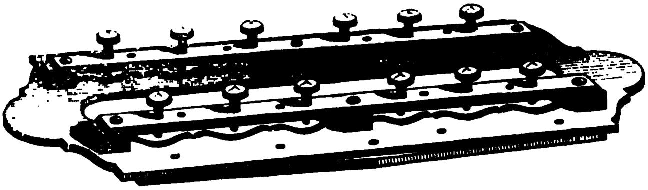
† See this Journal, iii. (1883) p. 278.

The novelty consists in the introduction of the tinted glass plates[*] *r r r* in the path of the rays from the mirror. Also the upper part of the apparatus (mirror *p*, its arm *a*, the glasses *r r r*, and the plate *o s*) is movable on the pivot *q* upon the lower plate, which forms part of the tube *h* fixed to the eye-piece by *k*.

**Millar's Multiple Stage-plate.**—The object of this stage-plate (fig. 19) is to facilitate the exhibition of a series of slides so that they may be observed successively without having to remove and replace each object separately.

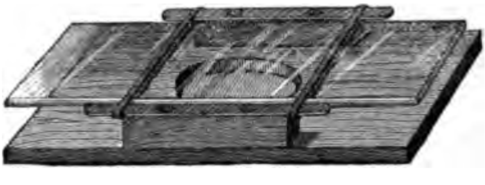
The base-plate slides on the stage after the upper stage-plate is taken off, and it holds six slides. Each of these is fixed by two small screws (passing through the two longitudinal bars) which press the slide against springs attached to the base-plate, there being six springs beneath each bar. The base-plate can be readily pushed in either direction by the hand when it is desired to examine a different object. The mechanical movements of the stage will bring various parts of an object into the field, but it is easy to adjust each slide on the plate in the first instance so that the object shall be central with the optic axis, there being sufficient spare room to move the slide both laterally and vertically.

Fig. 19.



**Stewart's Safety Stage-plate.**—This very simple device (fig. 20) was designed by Mr. C. Stewart to provide an economical but effective arrangement for protecting slides from breakage when being exhibited under high powers to large classes of students.

Fig. 20.



It consists of a wooden slip the length of an ordinary slide and rather wider, with a central aperture and two side pieces ($\frac{1}{4}$ in. high), capped with thin strips of brass projecting at either end of the uprights as shown in the fig. Across the projecting ends two small indiarubber rings are stretched and the slide is passed through these rings and thus suspended. If now the objective is brought down on the slide the latter sinks on the least pressure and ample warning is given to the observer.

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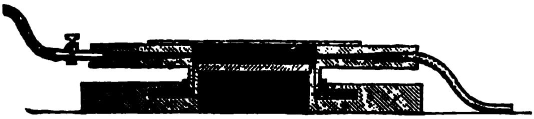
[*] See this Journal, iii. (1883) p. 119.

**Parsons' Current-Slide.**—Mr. P. B. Parsons has devised the new form of current-slide shown in figs. 21 (section) and 22 (perspective), which he describes as follows:—

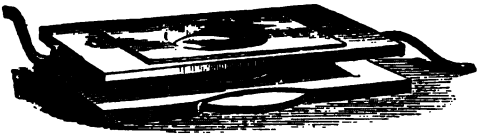
"The slide consists of two plates, pierced with central apertures surrounded by tubular projections, and fitting together like a live-box. The top one is raised or lowered by a milled head fixed to the lower one and working in a thread cut on the tube of the upper. Two pins prevent the plates from coming apart or turning on each other.

FIG. 21.



The top plate has a hole at one end for the water supply and a similar hole on the other for the waste, a piece of movable brass tube fitting into each.

FIG. 22.



The supply tube has a valve for regulating the quantity of water admitted, and beyond this is an indiarubber pipe connected with the water-vessel. A double-necked bottle is very convenient, so that a fresh supply of any fluid can be introduced without disturbing anything.

The advantages of this arrangement are:—

1. The depth of the cell is easily adjusted while on the stage, and the object can be brought within reach of fairly high powers by simply reducing the depth of water to a thin film. When not under examination with such powers the cell can be deepened, giving plenty of space with a constant current of fresh water, and yet enabling the observer to keep the object in view with a lower power.

2. The diameter of the cell, while large enough for all ordinary

purposes, admits of the use of very thin cover-glasses, ·005 or ·004 in., and when the cell is screwed up an 1/8 in., 1/10 in., or even 1/12 in. might be used if required.

3. The water supply is perfectly under control, and as there is at the same time no filtering action, the object can be supplied with water containing anything necessary to the life of the object.

4. The current is not interfered with by reducing the depth of the cell.

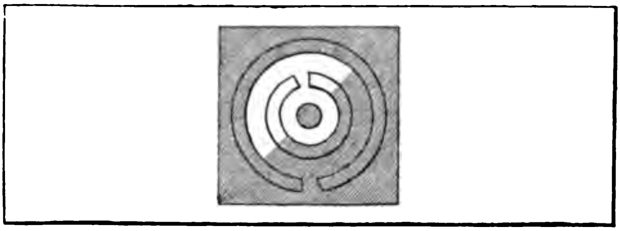
5. Objects can be easily put in, taken out, or manipulated in any way by stopping the supply and sliding the glass cover (which by preference should be square) downwards till the opening is large enough to do what is required. To replace the cover, slide it up till there is the least possible opening left and then fill up any air-space in the cell with water from a fine syringe before pushing it quite over the edge. If the under side of the cover-glass be slightly greased at the corners there will be no risk of it floating off.

This slide is manufactured by Messrs. Swift and Son, and can be made of varying depth and diameter to suit special purposes."

**Stokes's Growing-cell.***—Dr. A. C. Stokes cements to a slide a disk and two rings made from cover-glass,† the rings having a small piece broken away from each and arranged as shown in fig.

To use, place on the central disk a small drop of the water containing the organisms to be kept alive, and over it arrange a large square cover, taking pains to prevent the water from overflowing into the inner annular space. With a camel's hair pencil carefully, and in small quantities, add fresh water at the top or side of the square, until the space covered by the latter and bounded by the outer ring is filled. It will be found that this water will flow between the square and the upper surface of the exterior ring, will enter through the break in the latter, partially filling the outer annular space, and by capillary attraction will occupy a part of the vacancy between the cover and the interior ring, as shown by the diagonal lines in fig. 23, but unless too much water is used, or is supplied in too great quantities at a time, it will not pass the opening in the inner ring, thus leaving

Fig. 23.



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* Sci.-Gossip, 1884, pp. 8–9 (1 fig.).

† These can be punched out by the method described by Dr. Beale, 'How to Work with the Microscope,' 5th ed., 1880, p. 73.

an abundance of air to supply the animal life under observation. The imprisoned air at once becomes saturated with moisture, as evidenced by the fogginess of the cover; the central drop cannot evaporate, and the external water will not come in contact with it if care is taken in filling and in adding that lost by evaporation. When not in use, the slide is placed across a small vessel of water, a double and twisted thread arranged in contact with the edge of the square cover, and the whole left for another examination at some future time.

**Nunn's Pillar and other Slides.***—Dr. R. J. Nunn, under the heading of "*The Pillar-Slide—a new slide for the Microscope*," writes, "Every microscopist knows the difficulty of estimating exactly the amount of fluid which will completely fill the space between a cover and the slide, and consequently a bibulant must be applied to absorb the excess almost always present. This takes a little time, which, to one who has many examinations to make, and who is otherwise pressed, is a matter of some importance.

The following is a description of a slide intended to obviate this difficulty:—

Take a small thick cover (round or square, as desired) and cement it on the centre of a slide with Canada balsam. Let this harden thoroughly so that the cover will not slip during warm weather, and also to prevent water insinuating itself between the glasses during the frequent washing to which it will be subjected. Of course it would be better to have these little pillars ground upon the slides, but with care in using them the cemented ones will answer every purpose.

A drop of the fluid to be examined is placed upon the pillar just described, a cover larger than the pillar is placed upon it, when it will be seen that the excess of fluid flows into the annular space surrounding the pillar. Not the least advantage of this new form of slide is that evaporation takes place from the fluid in this annular space, and may go on for a long time without affecting the stratum under examination.

If desired, the annular space may be filled with oil, and evaporation thus be entirely prevented."

Under the heading of "*Chemical—new slide for the Microscope*," is the following:—"For the application of chemical tests to fluids under microscopical examination, the 'pillar slide' presents many advantages. The method usual in such cases is to place a drop of the reagent at one edge of the cover and a bit of blotting-paper at the opposite edge, with or without a hair inserted between the cover and the slide to facilitate the inflow of the reagent.

If the circular pillar-slide be used, then the cover must be pushed so that all the space is on one side; there will thus be formed a crescentic instead of an annular space. It is evident that in the latter, if the space is filled with reagent it will affect the film, but slowly, because evaporation takes place from the reagent itself, and there is nothing to draw it between the cover and the pillar. In the round pillar this is best corrected by having the diameter of the cover smaller than that of the pillar, and pushing it to one side so as to project a little beyond the pillar, the lunate space thus formed is filled with reagent, while the rest of the edge of cover is evaporating and drawing upon the reagent to supply the deficiency thus created, or, to hasten the reaction, a bit of blotting-paper may be applied in the usual way.

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* Sep. repr. from Trans. Med. Assoc. Georgia, 1883, pp. 21-4.

Another good way is to use a square cover: let one of the corners project beyond the pillar, and under this corner put the drop of reagent, in this way nearly the whole of the edge of the cover will be left free for evaporation, and the rapidity of the reaction will of course be proportionately great. If desired, a different reagent may be placed under each of the four projecting corners of the square cover.

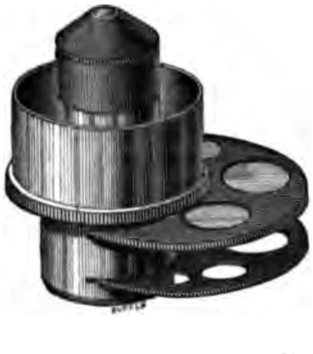
The 'square pillar-slide' seems, however, best adapted to this class of work, with a cover the same size or smaller than the pillar, and projecting a little beyond it; the reagent will then occupy one side of the square and evaporation go on from the other three sides. If an oblong cover is used which projects on opposite sides of the pillar, then the same or different reagents may be placed on opposite sides of the same specimen, without danger of mixing with each other."

Under "*Slides with hollows for chemical reactions*" Dr. Nunn says "Many of the advantages of the pillar slides for the observation of chemical reactions may be obtained by using polished glass slides with one or more hollows.

In using these the drop of fluid to be examined is placed by the side of the hollow, or between them, if there be two or more, and the cover is allowed to project over the hollow or hollows a little distance; under this projecting edge the drop of reagent is placed, and the bit of blotting-paper may be used as usual upon the slide if desired."

**Beck's Condenser with two Diaphragm-plates.**—Fig. 24 shows the condenser which accompanies Messrs. Beck's Pathological Microscope (Vol. III. 1883, p. 894). The peculiarity of its construction is that it has two rotating diaphragm-plates, one with the usual series of (7) apertures of different sizes, and the other with one clear aperture and three others filled with blue glass of varying tints, for moderating the light. The former is placed at a distance below the lenses sufficient for accurate centering of the condenser.

FIG. 24.

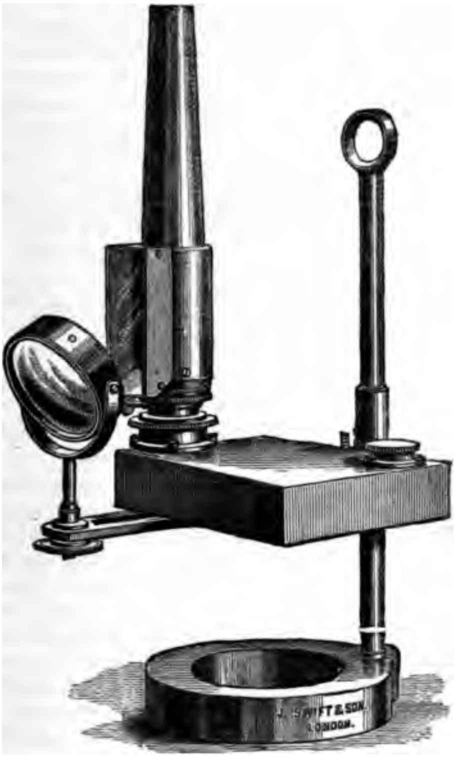


As shown in fig. 24, the condenser is for use with the smaller stands, but by reversing the optical combination and screwing it on the opposite side it is available for large stands.

By the removal of the sliding cap which carries the highest power lens of the three of which the optical combination is composed, the condenser is suitable for use with low-power objectives.

**Nelson's Microscope Lamp.**—Mr. E. M. Nelson some time ago devised the lamp shown in fig. 25; but no description or figure of it has been issued till now. The principal points in the design are (1) that the flame (using either the edge or the broadside) can be brought much nearer to the surface of the table than usual, which is secured by making the oil-well very shallow, large enough however to hold sufficient for eight or nine hours' work, and with means for replenishing the supply of oil without touching the flame; (2) the metal chimney is arranged to cut off all the light except that required for actual use with the Microscope, and the only glass required is an ordinary 3 × 1 slip which slides in a groove about an inch in front of the flame and can be readily removed for cleaning; (3) the condensing lens is of the compound Herschellian form, by which a clearer disk of light can be obtained than with the usual bull's-eye, and is provided with means of adjustment in all directions. The lamp was constructed by Messrs. Swift and Son.

FIG. 25.



**Developing Photo-micrographs.***—The microscopist who occasionally photographs his specimens finds that his developing solutions deteriorate by keeping, and often when he comes to use them, after standing untouched for some time, they do not act properly. Especially is this true of developers containing pyrogallic acid, which, as ordinarily made, soon lose their strength. It is customary to make up the solutions and keep them ready for use, but owing to the circumstances above mentioned, this plan is not a good one for microscopists who only use them occasionally.

Mr. R. Hitchcock has adopted the following plan for developing, which enables fresh solutions to be readily made without loss of time. There should be always at hand citric acid and pyrogallic acid in powder, strong ammonia (·880), and a solution of potassium bromide, 50 grains to the ounce of water. When about to develop the plates, dissolve 1·5 grains of citric acid in 8 ounces of water. In practice it is not necessary to weigh out the exact quantity, as it can be measured on the point of a knife, after a little experience. Then take half a drachm of ammonia and mix it with 8 ounces of water. Go into the dark room with the solutions, put the exposed plate into the developing dish, and proceed as follows: for a 4 × 5 plate take 1 ounce of citric acid solution and add to it 2 grains of the pyrogallic acid in powder, measuring that quantity in the hand, or on a spatula. It dissolves almost instantly. Then add one ounce of the ammonia solution and a drop or two of the bromide, and flow the whole over the plate. The development proceeds slowly, and may be controlled in the usual manner by adding more bromide, or a few drops of dilute ammonia, as the case may require.

**Action of a Diamond in Ruling Lines upon Glass.**†—Prof. W. A. Rogers writes, "In offering a communication upon the subject indicated by the title of this paper, I am not unmindful of the fact that I enter a field in which I acknowledge a master. Since the death of the incomparable Nobert, Mr. Fasoldt, of Albany, stands easily first in the art of fine ruling. I desire to repeat here the reply which for the past three years I have invariably made to inquiries for test-plates from my own machine—viz. that with Mr. Fasoldt's special facilities for this class of work he can, I have no doubt, produce far better results than it would be possible for me to obtain by chance efforts. I have thought it better to confine my attention to another equally important problem—viz. an attempt to obtain copies of the imperial yard and of the *mètre des archives*, at the temperature at which they are standard, to subdivide these units into aliquot parts and then to obtain a microscopical unit whose subdivisions should be so nearly equal that the Microscope would fail to reveal the difference. The first part of this work has been mainly completed. Two independently obtained copies of the imperial yard yield nearly identical values for the length of this standard unit. Three independent comparisons with the *mètre des archives* agree within very narrow limits in defining the absolute length of the metric unit, both of 32 and 62 degrees Fahrenheit. The subdivision of these units into aliquot parts—the yard into inches and the metre into centimetres—has been so far completed that any errors which may remain will not affect the microscopical unit sought. With regard to the exact subdivision of these units, I can only report progress.

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* Amer. Mon. Micr. Journ., iv. (1883) p. 198.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 149-65.

Notwithstanding this abandonment of attempts to produce test-bands of the Nobert pattern, I have recently taken up the subject again, somewhat with the view of testing the claim of Mr. Fasoldt that he has succeeded in ruling lines one million to the inch, and especially by the claim that the existence of a spectrum in the bands is an evidence of the reality of the separate lines. The latter claim does not appear to be well founded. Aside from being at variance with theory, it can easily be disproved experimentally.

Before proceeding further with this investigation, I beg to refer to a theory proposed by the writer in a paper presented to the American Academy of Arts and Sciences, in relation to the method which Nobert may possibly have employed in the production of his test-plates. Briefly stated, this theory is that the lines composing Nobert's bands are produced by a single crystal of the ruling diamond, whose ruling qualities improve with use. In the light of subsequent experience this theory may be stated in the following way: When a diamond is ground to a knife-edge, this edge is still made up of separate crystals, though we may not be able to see them, and a perfect line is obtained only when the ruling is done by a single crystal. When a good knife-edge has been obtained the preparation for ruling consists in finding a good crystal. Occasionally excellent ruling crystals are obtained by splitting a diamond in the direction of one or more of the twenty-four cleavage planes which are found in a perfectly formed crystal. A ruling point formed in this way is, however, very easily broken, and soon wears out. Experience has shown that the best results are obtained by choosing a crystal having one glazed surface and splitting off the opposite face. By grinding this split face, a knife-edge is formed against the natural face of the diamond, which will remain in good condition for a long time. When a ruling crystal has been found which will produce moderately heavy lines of the finest quality, it is at first generally too sharp for ruling lines finer than 20,000 or 30,000 to the inch, even with the lightest possible pressure of the surface of the glass. But gradually the edges of this cutting crystal wear away by use until at last this particular crystal takes the form of a true knife-edge, which is parallel with the line of motion of the ruling slide. In other words, when a diamond has been so adjusted as to yield lines of the best character its ruling qualities improve with use. If Nobert had any so-called 'secret,' I believe this to have been its substance.

The problem of fine ruling consists of two parts—first, in tracing lines of varying degrees of fineness; and, second, in making the interlinear spaces equal. The latter part of the problem is purely mechanical, and presents no difficulties which cannot be overcome by mechanical skill.

It will be the aim of the present paper to describe the more marked characteristics of lines of good quality ruled upon glass, and to illustrate these characteristics by corresponding specimens. To one who is familiar with Nobert's bands a perfect line need not be described. It is densely black, with at least one edge sharply defined. Both edges are perfectly smooth. Add to these characteristics a rich black gloss, and you have a picture of the coarser lines of a perfect Nobert plate. How are those lines produced? In the study of the action of a diamond in producing a breaking fracture in glass the Microscope seems to be of little service, but we can call it to our aid in the study of its action in ruling smooth lines. One would naturally suppose that a line of the best quality would be produced by the stoppage of the light under which it is viewed by the opaque groove which is cut by the ruling diamond. Without doubt this is the way in which lines are generally formed. But it is not the only way in which they can be produced. An examination under the Microscope will reveal the fact that in some instances at least, a portion of the glass is actually removed from the groove cut by the diamond; and that the minute particles of glass thus removed are sometimes laid up in a windrow beside the real line, as a plough turns up a furrow of soil. On the finest plate I have ever produced every line remained in perfect form for about two months. I then first noticed a tendency on the part of some of the single lines to disintegrate, while the lines ruled in closer bands seemed to retain their good qualities. This disintegration finally became so marked that, as an experiment, I removed the cover and cleaned one-half of the surface of the glass by rubbing with chamois skin. The difference in the appearance of the two halves is now very marked. Above, the dense black lines remain. Below, a ragged abrasion of the surface of the glass has taken place. Above, the furrowed lines as originally formed are preserved; below, there is a coarse scratch. It may be said that the action in this case is accidental and abnormal. In reply, I can say I have prepared plates which show that the particles of glass removed take four characteristic forms. (*a*) They appear as chips scattered over the surface of the glass. (*b*) They appear as particles so minute that when laid upon a windrow and forming an apparent line, they cannot be separated under the Microscope. (*c*) They take the form of filaments when the glass is sufficiently tough for them to be maintained unbroken. (*d*) They take a circular form.

I regret that three of the most striking specimens were broken in mounting. In one a perfect line about 1/30,000 of an inch in width was formed with a clear space between it and the groove cut by the diamond. There was not a single break in these filaments from beginning to end, but at nearly equal intervals of about 1/100 of an inch half-knots were formed similar to those formed in a partially twisted cord. By rubbing the surface of one end these filaments were broken up. For the most part they assumed a semicircular form, but some of them maintained their thread-like form and became twisted together in the most intricate fashion.

In the third specimen, which was broken in mounting, the glass removed took a spiral form like the spiral chips from steel when turned in a lathe. A projecting crystal of the diamond caught these spirals and carried them unbroken to the end of each line, leaving them a tangled mass of threads. Even after they were protected by a cover-glass cemented to the surface, many of these spirals remained intact. Judging by the difference in focus of the various parts, the height of the mass, before the plate was covered, must have been 1/500 of an inch.

The same ruling crystal may produce smooth lines or either chips or threads, according to the motion of the diamond, as may be seen by examination of the accompanying rulings In these plates one-half of the lines of the bands are ruled by a forward motion and one-half by a backward motion of the diamond. Chips may be formed in ruling bands of very fine lines, as illustrated in the bands of lines 24,000 to the inch.

It must not, however, be supposed that lines of the best quality always present the appearance described above. While it is exceedingly rare that lines appear as well after the surface of the glass has been rubbed as before, many instances have occurred within my experience in which the difference, especially in fine lines, was not particularly noticeable. According to the limited evidence at hand, the coarser lines of Nobert's bands present some of the characteristics which I have described. I have restored two of these plates, in which the lines had become nearly obliterated by some kind of condensation under the cover-glass. In one the quality of the lines was not much affected by the operation of cleaning, but in the other the dark gloss which characterizes the heavy lines of nearly all of Nobert's plates was entirely destroyed. The finer lines, however, were much less affected than the coarse ones.

Lines of the character thus far described are evidently unsuited to the ordinary work of the microscopist. It is my experience that lines which are the most symmetrical in form and the most beautiful in appearance are produced indirectly rather than by the direct action of the diamond in cutting a groove in the glass. They can be protected to a certain extent by a cover-glass, but they are liable to undergo changes which will affect their original structure. Except for purposes of investigation, therefore, there is no advantage to be gained by ruling lines of this character. Three conditions must be fulfilled in the production of lines having a permanently good character :—

1. The glass must be tough. There is a marked difference in the character of the filaments produced, and, to a certain extent, of the lines themselves, yet the conditions under which the lines in the series of plates illustrating this paper were ruled were the same in nearly all of the plates – i.e. the same diamond was used, its setting remained unchanged, and there was no change in the pressure of the diamond upon the surface of the glass. I may add also, that I have in my collection several other plates which were ruled especially to test the question of the requisite quality of the glass. They all agree in giving evidence that glass of a given quality will always yield lines of nearly the same quality—the ruling crystal remaining the same and in the same position.

2. The greatest difficulty encountered in setting a ruling crystal is to obtain one which will rule lines of the required quality which will retain their form after the surface of the glass is rubbed. The crystal with which nearly all the plates of this series were ruled was only obtained after a search continued at intervals through several weeks. Sometimes a diamond which will rule good light lines will not produce good heavy lines, and *vice versâ*. According to my experience it is better to have a special diamond for each class of line desired, though the diamond with which the present series of plates was ruled seems well adapted to every kind of work required, except, perhaps, the production of the finest bands. An examination of plates illustrates the wide difference in the character of lines ruled with the same diamond, after the edges of the ruling crystal have been worn smooth. In one there are two sets of lines, side by side, in one of which the surface has been rubbed, and in the other of which the lines have been left undisturbed. The difference is very marked. It may be said here that the surface of a ruled plate should always be cleaned by rubbing in the direction of the lines only, never at right angles to the lines. It will often happen after sharp rubbing that the lines appear ragged, when the difficulty is that the chips have not all been removed from the grooves. Rubbing with Vienna lime, moistened with alcohol, will usually complete the cleaning satisfactorily.

3. After a crystal has been found which will fulfil the conditions of producing a line which will bear cleaning, there still remains a difficulty which will only be revealed after the lapse of considerable time. This is well illustrated in one plate in which the lines were as perfect as could be desired for several days after they were ruled. The lines of the band are now completely broken up. Evidently they were in a state of strain, which finally became so great that resistance to rupture became impossible. This, however, is an extreme case. Generally the lines simply enlarge at certain points. Usually the termination of the enlargement occurs at irregular distances along the lines, and it is nearly always very sharply defined. The most curious action of this kind which has ever come under my notice is where the lines have broken up into a form something like the strand of a heavy rope.

The process of setting a diamond is as follows: The holder has the means of adjustment in three planes: (*a*) an adjustment in a horizontal plane; (*b*) an adjustment in a vertical plane; (*c*) an adjustment in a plane at right angles to the ruled lines. It is my practice to begin by giving the knife-edge of the diamond considerable inclination to the line of motion of the ruling slide. I then rule a series of single lines at different known angles of inclination, care being taken to pass the line of parallelism. An examination of the character of the lines thus ruled will enable one to determine within narrow limits near which one the knife-edge is set parallel with the slide. After a fair line has been obtained in this way a sharp crystal is generally found by tilting the diamond in a vertical plane, though it will often be found necessary to make the third adjustment mentioned. Sometimes the cutting crystal is lost after ruling a few lines, but generally good results can be obtained after a constant service of weeks, and even months. A crystal is lost either by being broken off or by being worn out. When a crystal has been lost it need not be concluded that the diamond needs sharpening. It is only necessary to find a new crystal, an operation requiring patience rather than skill.

It should be stated, that while this theory of individual cutting-crystals seems to be the true one, I have never been able to detect them by an examination with the Microscope. It is only by their behaviour that their existence can be recognized.

One of the most severe tests of the ruling qualities of a crystal consists in producing, without fracture, heavy lines which cross each other at a small angle of inclination, and which will receive graphite without interruption of continuity at the intersection. Lines ruled at right angles and forming small squares afford a better test than parallel lines. In one plate presented the curved lines formed by the intersection of straight lines are nearly perfect in form, and they hold the graphite quite as well as the original lines. In another plate I have attempted a representation of the nucleus of a comet. The filling is not quite as perfect as in the other plate, but this is due to the quality of the glass. Attention is called to the granular structure under a moderately high power. I have found rulings of this form to be an excellent test of the quality of the glass required for receiving the best lines. In general, the first filling of the lines is the most perfect. One plate affords an illustration, exceedingly rare, of lines which receive the lines equally well after repeated fillings. Lines as fine as 50,000 to the inch very readily receive the graphite. The limit beyond which it seems impossible to go may be placed at about 100,000 to the inch.

A few words may properly be added here with regard to the protection of ruled lines. When lines are formed by a true groove in the glass, it is better that they should remain unprotected. But when the lines are formed in the manner illustrated by the plates of this series, the quality of the lines in the end is pretty sure to deteriorate whenever there is an actual contact of the cover-glass with the slide. I have made serious efforts to overcome this difficulty, but with only partial success. Slides mounted with gutta-percha rings generally remain in good condition for a long time, especially if, after expelling the air as far as possible by heat, a ring of white wax cements the rim of the cover-glass to the slide. But even with this precaution there is no certainty of final preservation. If it should be found that the brass slides of this series are convenient in manipulation, their adoption can be recommended, since they entirely obviate this difficulty. They are made in the following way:—A hole having been made in the centre, a flange is left 1/200 in. in thickness. The cover-glass is then cemented to the surface of the brass, and the rulings are made on the under side. The protection is made by dropping upon the ledge of brass a rather thick circle of cover-glass, which is held in position by a circular brass wire.

After this digression, I return to the consideration of the credibility of Mr. Fasoldt's claim that he has succeeded in ruling lines 1,000,000 to the inch. At this point it is only fair to say that until recently I have shared in the general incredulity with which Mr. Fasoldt's claim has been regarded. Indeed, I still think he has placed the limit just a trifle too high. But if the limit is reduced one-half, I am by no means sure but that it may be reached. Possibly it may have been already reached. But what evidence have we that it is possible to see single lines of this degree of fineness, granting that it is possible to produce them? The answer to this question involves another inquiry, viz. has the Microscope reached its highest visual possibilities? Here again it is necessary to draw a sharp distinction between visibility and resolution. In the matter of limit of resolution it must be admitted that little or no progress has been made since the resolution of Nobert's nineteenth band. The distinguishing feature of Nobert's lines is a certain boldness which enables them to be photographed, and it is to photography, supplemented by the statement of the maker, that we owe the certainty of the resolution of the nineteenth band. But all attempts to go beyond this band, even with Nobert's later plates, have proved failures. I cannot learn that any one has yet succeeded in photographing a Fasoldt plate as high as 100,000 to the inch. Certainly various attempts which have been made with bands of my own ruling higher than about 70,000 have not been successful. There are several Nobert plates of the new pattern in this country. They run as high as 240,000 lines to the inch,* but who has gone beyond the number of lines in the nineteenth band? † With great respect for the honest belief of several microscopists who claim to have resolved Fasoldt's bands as high as 152,000 to the inch, I must yet hold to the opinion that in no case has the resolution been proved by a test which will be generally accepted by microscopists. There is one test, and only one, which is absolutely decisive—viz. the one originally proposed by Nobert, that of ruling a definite number of lines in a band of given fineness, and keeping the number secret until the microscopist could give the correct count, not merely in one instance but in several. Even here we must depend upon the honesty of the maker in revealing the correct count. Has the correct count been made in any Fasoldt plate as high as 100,000 to the inch? I think not. Has it been done with any band of my own ruling of the same degree of fineness? No. Let us marshal the evidence pro and con, offered by experience.

(*a*) Mr. Fasoldt's finest bands present a perfectly smooth and uniform surface. They have well-defined limits, and the width of the bands is what it should be by the number of lines claimed to be ruled.

(*b*) According to present experience single lines can be ruled several degrees finer than I have been able to detect under the Microscope. About four years since I sent to Prof. J. Edwards Smith a ruled plate with a statement of the number of bands, accompanied with a description of the same. Soon after I received a letter from Prof. Smith, saying there must be some mistake in the description, as he was unable to find two of the bands. I replied that the bands were certainly ruled, and that I thought I could convince him of that fact. I therefore requested him to re-examine the plate with the greatest care, and if he was still unable to find the bands to return the plate to me. After a vain endeavour to discover them the plate was sent to me. I removed the cover, filled the lines with graphite, remounted the slide, and returned it to Prof. Smith. Not only had the invisible bands become visible, but the separate lines, with an interlinear space of 1/80,000 in., were easily seen. Now when Prof. J. Edwards Smith, an acknowledged expert in the manipulation of the Microscope, is unable to find lines which are really in the centre of the field of the Microscope, I suspect that other observers may find a similar difficulty. Among the plates presented is one series which were ruled to illustrate the possibility of producing lines which really exist, but which are invisible under the Microscope. On one plate there are two sets of lines, one set on the slide and the other on the under side of the cover. Between the bands, 10,000 and 24,000 to the inch, the entire intervening space is filled with a continuous series of bands, 24,000 to the inch. I have not been able to see the lines of the last band. In another plate there are a series of bands containing twenty-one lines each, the entire linear space being 1/2000 in. The first eleven lines are ruled with a forward motion of the diamond, and the second ten lines are ruled with a backward motion. The last two bands are preceded by heavy finding lines. Each of the last three bands is followed by bands 24,000 to the inch. I think it will be found difficult to see the lines of the last two bands under any illumination at present in use, and yet I am confident that the lines exist. I found my belief upon two bits of evidence: First, the pressure of the diamond upon the glass was sufficient to produce the lines. With considerable less pressure there would still have been a constant contact between the diamond and the glass. Second, I saw them ruled through the sense of hearing. When a diamond does its very best work it produces a sharp, singing tone, which is audible at a distance as great as twelve inches. This singing tone I distinctly heard for every line ruled. It is even more marked in ruling the finest lines than in coarse ones. I have two singing diamonds, or rather two diamonds with singing crystals, and these two are the ones with which I have done my best work.

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* The highest is 1/20,000 of a Paris line, i. e. 224,000 to the English inch.—Ed. J.R.M.S.

† Mr. E. M. Nelson claims to have resolved the next finest band to the 19th, viz. the 11th band of the latest 20 band plate, the lines of which are at the rate of about 123,000 to the inch.—Ed. J.R.M S.

The argument against the visibility of single-ruled lines which cannot be seen with the present means at command, even if within the limits of possibility, considered in a physiological sense, is in one respect a sufficient answer to the evidence offered in favour of their existence. This evidence, while not exactly negative in its character, is yet not sufficiently conclusive to be regarded as coming under the head of proof through the medium by which the existence of any fact is attested, viz. the medium of some one of the senses. But may it not be true that we have not yet reached the fulfilment of the conditions necessary to visibility? It certainly cannot yet be safely asserted that it is impossible to see a material particle which has, in one direction, a magnitude not exceeding 1/500,000 in. Photography offers the evidence, somewhat negative in its character, that the limit of visibility is reached with lines having a width of about 1/200,000 of an inch. Lines of this width are the finest that have ever been photographed. But the most conclusive evidence against the certainty of being able to produce lines as fine as 500,000 to the inch consists in the fact, repeatedly proven in my own experience, that lines which appear to be excessively fine often have a real width two or three times as great as they appear to have, as has been proved conclusively by filling the lines with graphite, which brings out the real limit. This phenomenon will come up again in connection with the subject of resolution.

I have already stated my belief that the limit of resolution has been so nearly reached that, though it is quite possible under a combination of favourable circumstances to obtain a resolution a little beyond 113,000 to the inch, the uncertainty which must always attend observations of this character is so great that the certainty of resolution cannot be safely asserted. In consideration of this uncertainty, and of the fact that so little progress has been made in resolution compared with the recent advance in the construction of objectives, I beg to propose as a test the visibility of single-ruled lines in place of the resolution of these lines in close combination. Instead of bands of lines of the Nobert pattern, I propose a series of bands, each having the same interlinear unit, but with the lines of each successive band finer than those of the preceding band. The space between the lines should not be so great as to interfere with their easy detection, nor so small as to require any effort in resolution. One micron ($\mu$) is a convenient unit. A heavy line should precede the band, in order to facilitate finding it.

According to my own experience there are four facts which must always throw grave doubt upon any reported case of difficult resolution:—

1. It is well known that by the manipulation of the light, every other condition remaining the same, it is possible to vary the apparent number of lines in a given band of coarse rulings. Can any one offer a reason why there should not be the same difference with bands of fine lines closely ruled?

2. I have many times ruled bands of lines with the interlinear spaces distinctly marked, but in which each line was in reality considerably wider than the space between the lines, as I have proved by extending single lines beyond the others and filling them with graphite. The only explanation of this singular fact which I can suggest is that the diamond may possibly cut square down at one edge of the line and for the remainder of the line produce only an abrasion of the surface of the glass, which is so slight as not to interfere with throwing up a furrow upon the remaining portion.

3. Lines of a given depth appear finer when closely ruled in bands than they do in single lines.

4. I add another observation with some hesitation, since I have not been able to prove its truth beyond peradventure. I have often, but not always, found that when single lines, apparently invisible, are placed in close combination in bands, they not only form a visible band, but a band capable of apparent resolution into separate lines. Can any one offer a reason why we can see in combination what we cannot see as separate parts? Of course I shall be at once reminded by the astronomer that it is much easier to pick up a cluster than to see scattered stars of the same magnitude. But when it is once found, the separate stars composing it are no more easily seen than stars of the same magnitude more widely scattered. I offer this observation in a tentative way, since it has, if true, an important bearing upon the question of the ultimate limit of resolution. Among the accompanying plates is one that illustrates the statement here made. This plate consists of a series of bands, 12,000 to 24,000 to the inch, each preceded by a heavy finding line. The lines of each successive band are finer than the preceding. The last two bands were ruled with the same pressure of the diamond as the fourth band preceding. The intervals at which they were ruled are 1/80,000 and 1/200,000 in. I do not by any means vouch for the existence of the separate lines, yet the bands are smooth, and there is a distinct difference in the appearance of the two halves of the 80,000 band, the first having been ruled with a forward and the second with a backward motion of the diamond. The corresponding single lines of the fourth band preceding are wholly invisible. This plate seems to show that the visibility of the lines in bands depends somewhat on the narrowness of the interval between the lines, since the lines of the same degree of fineness with an interval of 1/24,000 in. cannot be seen.

It is obvious that this whole question of resolution needs the most careful consideration and investigation, since it bears an intimate relation to the limit of visibility of single particles of matter. Mr. Hitchcock, in a recent number of his 'Journal,' has made the claim that resolution has to a certain extent ceased to be a test of the quality of an objective. I suspect that this claim will be found to have some foundation in fact. For the last ten years we have only the assertion of resolution, without doubt honestly made, but yet unaccompanied with the proof. It is time that the proof should accompany the assertion. I insist that simple vision does not afford the required proof.

Now we must face this question as honest inquirers after truth. There is a limit which theory places to resolution with objectives of given resolving power, not to visibility, as has been frequently stated. Before we can safely assert that observation has gone beyond theory, we must be prepared to offer evidence which can be placed upon record, can be discussed deliberately, can be weighed impartially in the balance with counter evidence, and can still stand unimpeached. Do you say that this is hardly worth the trouble? I reply that the issue here raised comes to the surface in one form or another at almost every point in physiological and pathological investigations. It will do no harm to recall the number of times it has at this meeting stood as a sentinel at the entrance to the temple whose mysteries we are seeking to explore. Has not the question so tersely put by Dr. Gleason at the Elmira meeting of this Society, 'Do we see what we see, or don't we see what we see, or do we see what we don't see?' been the stopping place of more than one important issue raised at the meeting? I hope I do not need to say that I have no personal ends to serve in an inquiry in which I happen to be a personal factor. Let us then have a test which will for ever set at rest this vexed question of resolution. I submit for your consideration the following outline of a test which I venture to think will be sufficient and conclusive. Let Mr. Fasoldt rule three plates under as nearly the same conditions as possible, except in the number of lines in the different bands of each plate. Let him label each plate and accompany it with a full description of the number of lines in each band. Let these plates be sent to any gentleman in whom the great body of microscopists have confidence as eminently qualified to conduct an investigation of this sort, such as Prof. H. L. Smith of Geneva, or Col. J. J. Woodward of Washington. Let whoever receives the plates remove the labels of Mr. Fasoldt, and put in their place labels whose signification is known only to himself. Then let the gentlemen who think they have resolved 152,000 lines to the inch take the plates, make their count of the lines in each band, and send in their report. Let the plates also be photographed, and let the number of lines be counted; then let the results of these investigations be published. If all substantially agree in the count, this will end further discussion.

The limit of visibility of single particles of matter under the Microscope bears an intimate relation to the limit of naked-eye visibility. My attention was first called to the smallness of this limit by an accidental circumstance. I had ruled a micrometer upon a thin cover-glass consisting, as I supposed, of moderately coarse lines. After several vain attempts to discover traces of the lines ruled, I chanced while holding the glass at a certain angle with respect to the source of light to breathe upon it. At the instant the film of moisture was passing off, I was surprised to be able to see all the lines which were ruled, 100 to the inch, with the greatest distinctness. I then carefully filled the lines with graphite, when they were, after the closest inspection, found to be as fine as any I have ever ruled. According to the nearest measurement I could make, their width was about 1/6 of a micron. Repeated observations gave in every case satisfactory evidence of visibility. In order to ascertain what effect the thickness of the glass might have upon the visibility, the cover-glass was lightly cemented to a glass slide with guttapercha, when it was found that the lines were by no means as distinctly visible as before. The cover was then removed, when the original observation was easily confirmed. The lines of this plate were readily seen by Professor Pickering, and by several assistants connected with the observatory. Unfortunately the glass was broken in an attempt to mount it upon a brass slide. While it is a simple matter to rule lines which are easily visible by the unaided eye, especially in sunlight, having a width not exceeding 1/50,000 in., I have never since succeeded in obtaining a plate quite as good as the one described. Clearly the ruling crystal had been broken off before this particular plate was ruled, and, as often happens, a minute and delicate crystal remained, which produced the lines which were really traced.

In the course of subsequent experiments I found that while the visibility was increased by the film of moisture, exceedingly fine lines could be seen without this aid to vision when the proper angles of inclination to the source of light are obtained. To get the best results the ruled surface should have an angle of about 15° with the source of light, and the lines themselves should have nearly the same angle of inclination. Everything depends upon getting the exact angles of inclination required. More striking results are obtained by sunlight than by artificial light. Highly polished metals, especially tempered steel and iridium, yield better results than glass. I will not undertake to say how fine lines traced upon metal can be seen, but I suspect that the limit of naked-eye visibility is far beyond the capacity of ruling. I have a plate of highly polished and nearly pure iridium upon which there are traced a series of lines which are discernible by the eye in sunlight, but which I have never yet been able to see under the Microscope by direct light. Yet these lines are easily seen with a low-power objective under certain conditions.

I do not propose to offer any theory to account for the facts which I have observed, not even the one which would naturally be the one first suggested—viz. that of visibility by reflection. I admit that the apparent width of the lines would be increased if the real and reflected lines could be seen side by side. It can be easily shown that the lines in one of the accompanying plates are visible under conditions in which it is impossible for reflection to take place. For the present I content myself with stating the facts of observation illustrated by the ruled plates by which these observations can be repeated.

I close this paper with the suggestion that the increase in the efficiency of the Microscope will probably come from the better manipulation of the light under which an object is viewed. At present the unaided eye is a not very unequal competitor of the Microscope in the matter of simple vision. In fact, there are certain phenomena connected with this question which can be better studied by the unaided eye than under the Microscope. I believe it to be possible to see under the action of sunlight what cannot be seen under any objective. There has been produced upon my ruling-machine, upon a polished surface of tempered steel, a band of 10,000 lines, covering a space of 4 inches. I have tested the equality of the spacing for aliquot parts of a revolution of the screw in every possible way by direct measurement. Other observers have done the same thing. I can hardly be wrong in the assertion that the spaces indicated by even tenths of a revolution are exactly equal as far as any tests of direct measurement can be applied. Yet, by holding this bar in a certain position with respect to the source of light, the limits of each revolution of the screw can be distinctly seen. These waves of light and shade indicate an error which can be seen by the unaided eye but which cannot be measured with certainty. Finally, if the visibility of ruled lines is so erroneously increased by the position which they occupy with respect to the source of light, why may not the visibility under the Microscope be increased in nearly the same proportion by some mechanical device which shall enable the observer to find exactly the proper angle of inclination at which the light should be thrown upon the object in order to secure the best possible result?"

Prof. Rogers, in the discussion on a paper by Dr. G. E. Blackham on the Relation of Aperture to Amplification, also said * "The whole thing depends on the question Can we compute resolving powers? I will not say that we cannot, and I have my doubts if we can. I question the truthfulness of the formula that is used in the computation. My confidence in it was shaken some time ago, when in the measurement of some plates I found errors of 1/40,000 in. I think that the formula is true, so far as it goes, but it does not tell the whole truth. There are conditions that affect it. Take, for instance, Bayard's formula for refractions. It is affected by the atmosphere and temperature. Now, I do not say that the two formulas are analogous; I use Bayard's only as an illustration of what may occur. My position is this: Take what we have as a basis of investigation, and go ahead to ascertain the truth. There is a great sea for exploration in the question."

**Test-Diatoms in Phosphorus and Monobromide of Naphthaline.**† —Canon E. Carr thinks those who are interested in the resolution of the more finely marked diatoms, and who have seen or heard of the magnificent image of *Surirella gemma*, mounted in phosphorus, shown by Mr. J. W. Stephenson at the Society's meetings and conversazioni, with a Zeiss' oil-immersion 1/8 objective and his own catoptric illuminator, will be glad to learn that Möller now supplies some of the more difficult test-objects mounted in highly refractive media. Having recently purchased a slide of *Amphipleura pellucida* mounted in phosphorus, and one of *Surirella gemma* mounted in monobromide of naphthaline, he gives the result of his examination of them. The resolution of the hemispherules on the latter was not remarkable, being much the same as that obtained on a slide of the object mounted dry. The resolution of the former, however, was all that could be desired with the means at command, and contrasted favourably with anything he had seen before. Previously, with a Powell and Lealand's water-immersion 1/8 objective, and Wenham disk illuminator, he had seen the striæ very faintly shown on a balsam-mounted slide. Much better resolution had been effected on a dry mount by a Powell oil-immersion 1/25 objective, and their achromatic condenser. But even this result was not to be compared with that obtained on the phosphorus mount. Using Powell's oil-immersion 1/12 objective (N.A. 1·43), and their oil-immersion condenser, the striæ came out remarkably clear and sharp, and, though not distinctly broken up into dots, gave apparent indications of a want of continuity. It would be interesting (he adds) if other observers who possess large-angled object-glasses, and corresponding means of illumination, would give their experience in regard to the new slides of these difficult but fascinating objects.

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* Loc. cit., pp. 227-8.

† Engl. Mech., xxxviii. (1883) p. 280.

**Microscopic Test-Objects.**[*] — Under the above title Mr. E. M. Nelson replied to Canon Carr as follows :—" Having worked at these objects for some years, and having also kept pace with the times in objectives and apparatus, I will, in answer to Mr. Carr's request, give the results of my experience: 1st, the total abolition of oblique illumination if one wishes to see the true structure of an object; 2nd, object mounted dry on cover.

I use a Powell achromatic condenser, accurately centred to the optic axis. The edge of the flame of a paraffin lamp, with 1/2 in. wick, exactly focused on the object, without bull's-eye or mirror. This illumination, with a Powell oil 1/12, N.A. 1·43, easily resolves *A. pellucida*, dry on cover, *with direct light*—i. e. without slot or stop.

If *S. gemma* is examined by this means, the hemispherule theory is at once exploded, and the true structure (which is far more beautiful) is revealed. It is something like a most delicate skeleton leaf. This, however, is very difficult for a beginner. The *P. formosum* is, perhaps, the best one to try first. Work away at that until the hemispheres, which are so easily seen, give place to a *square* grating! To see this, with a 1/4, N.A. ·74, will severely test the lens and the observer's manipulative skill. A coarse *N. lyra* and a *Tryblionella punctata* both have square apertures, and are very easy. N.B.—If the objective is much out of correction, the square apertures will blur round. The next one to try is *P. angulatum*. In this a fracture should be distinctly seen to pass *through* the apertures. The apertures will take a rose tint if the glass is properly corrected.

It is manifestly absurd to test an objective by a fine diatom seen with oblique light, for only a small portion of a narrow marginal zone of the objective is used. The central, and by far the more important, part of the glass might be stopped out.

By the central illumination, however, the whole of the objective is used; the centre by the dioptric beam, the margin by the diffraction pencils. In former days one used to hear this sort of thing said: 'This 1/12 is a beautiful diatom glass.' 'This 1/10 is splendid on *Podura*, but not good at diatom resolving.' (What a fine thing for the opticians! One had to buy two glasses, one for *Podura* and one for diatoms.) The explanation is very simple: for *Podura* a glass must be good in the centre, and for diatoms, with oblique light (the only light used in those days), good in the marginal zone. So then the 1/10, which was good for *Podura*, and the 1/12 for diatoms, could neither of them have been thoroughly corrected from their centres to their margins. I have a glass in my collection which is very fair on *Podura* when the screw-collar is in one position, and also is a good diatom resolver with its collar in another position; but when all its zones are tried at *once*, by the direct illumination, it utterly breaks down.

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[*] Engl. Mech., xxxviii. (1883) p. 324.

With regard to *A. pellucida*, the *strongest* resolution is obtained with Powell's vertical illuminator. The long striæ can only be seen by this method. Spurious longitudinal striæ may be easily seen; but the true lines are very difficult, and may be estimated to be 120,000 to the in. at the lowest. The transverse I have counted repeatedly, and find them, in Van Heurck's specimens, very constant at 95,000 per inch. The best picture of the trans-striæ is obtained with oil-immersion 1/12, N.A. 1·43, or oil-immersion 1/25, N.A. 1·38, and Powell's oil-immersion condenser, *used dry*, with single slot, edge of flame direct, valve being dry on cover. The lowest angled glass with which I have seen the transverse striæ, is a water-immersion 1/16, N.A. 1·08, and the lowest power 1/4, N.A. 1·17."

In reply to a letter from "Monachus" * inviting Mr. Nelson to state how he came to recognize that oblique illumination must be entirely abolished in favour of central, and that by so doing we shall see the *true* structure of the object, Mr. Nelson wrote: †—" I began to realize the uselessness of oblique light for the determination of true structure during a lengthened examination of a Nobert's 19-band plate. I was much struck by the appearance of a single line of the first band, when viewed by an oil-immersion N.A. 1·25, illuminated by a large angled cone of direct light. The groove which the diamond had ploughed in the glass was most distinctly seen, and along the sides of the groove there were places where the chips of glass had flown off. With oblique light all this was lost; the line appeared as if it had been painted on the surface of the glass. This showed me that if definition was wanted direct light must be used.

I do not intend for one moment to affirm that a higher band of Nobert can be resolved by direct than by oblique light; but this I do say, that the ultimate structure of a diatom can only be demonstrated by direct light.

No microscopist in the present day would uphold the theory that the ultimate resolution of the *P. angulatum* was six sets of lines or grooves, inclined at an angle of 60° to one another. But a similar view of it was held in Quekett's time, for in the frontispiece of his book there is a beautiful engraving of it, exhibiting diamond-shaped marks all over it; a false conclusion, the result of oblique light. Neither will any one insist that the ultimate resolution of the *N. Rhomboides* is represented by two sets of lines, at right angles to one another, a picture produced by the employment of two beams of oblique light. In the days of Griffith and Henfrey they got beyond that, and dotted the *Rhomboides*.

It is quite natural to expect that with the increase of aperture and the improvement in objectives there should be simultaneously a development in the resolution of the diatoms. One misses, too, with oblique light, all that beautiful tracery inside the hexagonal areolation of the *Coscinodisci*, which can only be seen by direct light; for with oblique light the blur of the hexagonal structure blots out the fine markings. When we come to the very finely-marked diatoms, such as *A. pellucida* and some of the *Nitzschiæ*, we must be content with lines, by oblique light, until we can get sufficient aperture to enable us to see the ultimate structure."

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* Engl. Mech., xxxviii. (1883) p. 341.

† Ibid., p. 386 (3 figs.).

"Monachus" rejoined as follows: *—"I am obliged to Mr. Nelson for his reply to my letter, as it leaves no room for ambiguity as to his views.

It is not of course my object, in occupying your space, to simply engage in a personal controversy with Mr. Nelson, and I therefore leave, for the moment at any rate, many points in his letters in regard to which he is mistaken, such as the statements about the two beams in the case of *N. Rhomboides*, the lines and dots he figures, &c. My object is to prevent your readers being misled on the cardinal statement of Mr. Nelson that he (or any one else) has seen the true structure of *Surirella gemma*, or any similar diatom. When this *is* seen we shall have reached the millennium of microscopical observation—how far we are from that day no one can tell, but it is certain we have not reached it yet; and in representing what he saw as the 'true structure,' Mr. Nelson was but falling into the same error as the old school of microscopists whom he criticizes.

I will first quote Mr. Nelson's statement *verbatim* :—'If *S. gemma* is examined by this means, the hemispherule theory is at once exploded, and the true structure (which is far more beautiful) is revealed. It is something like a most delicate skeleton leaf.'

Why *S. gemma* is beyond the reach of any such determination of its true structure, it is the object of the succeeding paragraphs to show.

When rays emanating from a luminous body are transmitted through any structure, which by its opaque, semi-transparent, or refractive constituents prevents the continuous propagation of the luminous waves, the rays cease to pass through in straight lines, and each pencil is split up into a conical pencil of rays, which are distributed round the course of the incident pencil, and which vary very much in the extent of their deviation.

When the elements of the structure are considerable multiples of a wave-length, that is, when they are relatively large, the spread of the diffracted rays is limited; but when the elements are only very small multiples of a wave-length, that is, when they are very minute, the diffracted rays are spread out very widely.

Most microscopists are by this time familiar with the practical effect of the diffraction-spectra under the Microscope, and have seen the experiments which show that the same diatom will give numerous very different images according as we admit all or some only of the diffraction-spectra. By stopping off successively the seven spectra, for instance, of *P. angulatum*, we get as many different structural appearances—indeed, no less than nine different sets of lines may be displayed on this diatom, according as we admit or exclude particular sets of spectra. The results obtained from this manipulation may be summarized in three propositions:—

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* Engl. Mech., xxxviii. (1883) p. 431 (1 fig.).

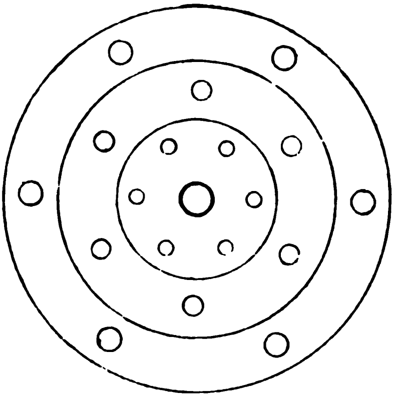
(1) The *same* structure will give *different* images when the diffraction-beams are made different.

(2) *Different* structures will give the *same* image when the diffraction-beams are made similar in each case.

(3) (the proposition which is most pertinent to our present subject). The microscopic image of a structure is never in perfect accordance with its actual composition, or true structure, unless *the whole of the diffraction-pencil is admitted to the Microscope*; or, in other words, the image is always more and more dissimilar from the true structure in proportion to the greater number of diffraction-pencils which are excluded from the Microscope.

The diagram will serve to illustrate the practical application of the last proposition to the examination of diatoms. If the structure is 'coarse,' the diffraction-beams will all be included within a small space around the central pencil (the inner circle of the figure), and in this case an objective, even of limited aperture, will receive them all, and we shall have an image of the true structure. If the object is finer, the limited aperture will not be sufficient to take up all the diffraction-pencils, but a larger aperture (the middle circle of the figure) will. Still more minute structure will require a still larger aperture, as is shown by the outer circle.

FIG. 26.



Now the elements of *S. gemma* are of such fineness that they far surpass the limits of any aperture that we are able to obtain at the present day. Aperture is limited by the refractive index of the glass of which the objectives are made, and that of the immersion fluid, cover-glass, and slide, and hitherto we have not been able to obtain more than 1·47 N.A. out of a possible 1·52. An aperture even of 1·52 would take up but a *part* of the diffraction-beams to which the structure of *S. gemma* gives rise, and, therefore, with our widest apertures it is impossible for us to see its true structure. I need not give the figures of the calculation here; but the fact is that to see the true structure in reality, we should require objectives, slides, and immersion fluids far surpassing in refractive index any substance hitherto known to exist in nature.

To quote Prof. Abbe: 'All speculations as to the true structure of even *P. angulatum*, so far as they depend on microscopic vision, are mere phantoms, castles-in-the-air. No human eye has ever seen, or will ever see, the complete diffraction-spectra arising from a structure of this minuteness, nor will any Microscope ever show an enlarged copy of it, so long as the spectra cannot be observed in a medium of at least 5·0 refractive index, and by an objective of 5·0 N.A., which, as far as our present knowledge goes, is an impossibility. The Microscopes of the present day admit relatively a small central portion of the whole diffraction-pencil of the valve—i.e. the incident beam and the six spectra of the inner circle. But this portion is also yielded by a multitude of other objects which are endowed with an alternation of superficial or internal molecular structures which cross each other in two different directions at an angle of 60°. Such structures may be formed in various widely different ways; it may be by rows of spherules or other prominences of any shape whatever; rows of internal vacuoles of any figure, or the mere internal alternations of molecular aggregations within a perfectly transparent and smooth silica film. And yet all of these yield with central light the identical circular field of the *angulatum* valve, even to the most minute particular. But although these spectra are identical as far as the six inner spectral beams are concerned, they may be vastly different in regard to some or all of the more widely diffracted pencils which are not admitted by the objective.'

However expert, therefore, a microscopist may be (and every one knows the high point which Mr. Nelson has reached), he must not delude himself with the notion that perfection in technical dexterity enables him to determine the "true" structure of objects whose real structure cannot be revealed with our present appliances by any amount of manipulation. The greater his own reputation in this respect, the more undesirable it is that he should proclaim such misleading views, to the perplexity of his less experienced brethren."

**Resolution of Amphipleura pellucida by Central Light.**—This has been the subject of some controversy in America. Mr. A. Y. Moore* considers the real explanation of the resolution when the mirror is central to be that the edge of the front cell of the objective radiates the light and all light reaching the bottom of the slide at a greater incidence than the critical angle is reflected upwards and enters the lens after having passed through the diatom.

Dr. H. J. Detmers† considers this explanation to be quite untenable and the true cause to be that "the resolving rays are reflected from the (externally convex) internally concave surface of the edge of the immersion fluid."

Prof. A. Y. Moore, in reply,‡ insists upon the correctness of his view and the insufficiency of that of Dr. Detmers, inasmuch as the field of view takes the colour of the metal of which the front cell of the objective is made. This would not occur if the light were reflected from the edge of the drop of immersion fluid.

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* The Microscope, iii. (1883) pp. 49–51 (1 fig.). Cf. this Journal, iii. (1883) p. 595.

† Ibid., pp. 197–201.

‡ Ibid., pp. 201–4.

**Albertotti**, G., jun.—Sulla Micrometria. (On Micrometry.) [*Post.*]
*Ann. di Ottalmologia*, XI. (1882) pp. 29–30 (1 pl.).
*Klin. Monatsbl. f. Augenheilkunde*, 1882.

**Anon.**—The Wonders of Optics.
[Inquiry for "a glass that I can see through paper or leather, and if you have one please to be kind enough to send me the price of it at once"; and reply of editor, "Punch a hole in the paper or leather."]
*Micr. Bulletin*, I. (1883) p. 7.

**Barlow**, T.—See Tolles, R. B.

Bausch and Lomb Optical Co.'s new pattern "Investigator Improved" Microscope, and 1/4 in. objective.
[Coarse adjustment moves nearly 2 in. higher—pillar heavier and higher—separable swinging tail-pieces—Objective with extra large working distance.]
*The Microscope*, III. (1883) p. 239.

**Bell**, J. S. B.—Warm Stage and Stage Condenser for Diatomaceæ.
[Warm stage *post.* Stage condenser "simply an addition of a shutter to the hemispherical lens . . . . similar to that used by Powell and Lealand."]
*Micr. News*, IV. (1884) pp. 19–20.

**Blackham**, G. E.—The relation of aperture to amplification in the selection of a series of Microscope Objectives. [*Post.*]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 33–41.
Discussion, pp. 227–31.

" " See also Tolles, R. B.

**Bradbury**, W.—The Achromatic Object-glass, XXIX.
*Engl. Mech.*, XXXVIII. (1883) pp. 258–9 (1 fig.).

" " On Eye-pieces. " " (1884) pp. 401–2.

**Bulloch**, W. H.—New Congress Nose-piece. Patented 1883. [*Supra*, p. 118.]
*The Microscope*, III. (1883) p. 218 (2 figs.).
Also U.S.A. Patent, No. 287904, of 23rd January, 1883.

C., J. A.—See Penny, W. G.

**Carr**, E.—Microscopic Test Objects. [*Supra*, p. 138.]
*Engl. Mech.*, XXXVIII. (1883) p. 280.

**Cohen**, E., and **Grimm**, J.—Sammlung von Mikrophotographien zur Veranschaulichung der Mikroskopischen Structur von Mineralien und Gesteinen. (Collection of micro-photographs for the demonstration of the microscopical structure of minerals and rocks.) Parts IX. and X. (conclusion). 38 pp. Plates 65–80. 4to, Stuttgart, 1883.

**Cohn**, F.—Bicentenary of Bacteria.
[Calls attention to the fact that, in a letter dated 14th September, 1683, A. van Leeuwenhoek gave notice to the Royal Society that with the aid of his Microscope he had discovered in the white substance adhering to his teeth very little animals moving in a very lively fashion. "They were the first bacteria the human eye ever saw." [See also "L.," *infra.*]
*Nature*, XXIX. (1883) p. 154.

**Colt**, J. B.—Determination of the Foci of Lenses.
U.S.A. Patent, No. 288025, of 17th September, 1883.

**Coombs**, C. P.—Address as President of the Postal Microscopical Society, 11th October, 1883.
[On "examining occasionally the food we eat or the clothes we wear."]
*Journ. of Microscopy*, III. (1884) pp. 1–7.

**Cox**, J. D.—A new form of Microscope stand with concentric movements. [*Post.*]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 147–8 (1 fig.).
Discussion, pp. 235–6.

D., E. T.—Graphic Microscopy.
[Description of coloured lithograph of *Tingis Crassiochari.*]
*Sci.-Gossip*, 1884, pp. 1–2 (1 pl.).

**Darling**, S.—Micrometer. U.S.A. Patent, No. 287420, of 1st March, 1883.

**D., E. T.**—Drawing from the Microscope.

[Points out the error of B. Hobson's suggestion—Vol. III. (1883) p. 725—of a semi-rotation of the stage to cure the inversion with the neutral tint reflector. Also remarks on the value of the camera lucida: "In microscopical work the camera lucida is merely a preliminary adjunct of limited utility in determining proportions; no graphic or perfect drawing is helped by its continued use; after affording the barest outlines and positions the instrument becomes an encumbrance, and those who are practised in its employment feel a palpable sense of relief, and breathe again, when it is got rid of, to settle down to the earnest work of direct vision from the Microscope."]

*Sci.-Gossip*, 1883, pp. 265–6 (1 fig.).

**DEAN, A.**—Microscopical.

[Description of a "micro-magic lantern" with or without camera lucida.]

*Engl. Mech.*, XXXVIII. (1884) p. 391 (1 fig.).

**DETMERS, H. J.**—Resolution of *Amphipleura* by sunlight, mirror-bar central; with letters from R. B. Tolles and A. Y. Moore.

*The Microscope*, III. (1883) pp. 197–201 and p. 221.

**DICKENSON.**—Art of photographing microscopic objects.

[The apparatus consists of (1) an inexpensive magic lantern, illuminated by a triplex petroleum lamp with the ordinary combination of lenses, and an extra tube with a small bull's-eye condenser; (2) a Microscope, placed horizontally, without the eye-piece; and (3) a frame to hold the glass screen for focusing the image, and to receive the sensitized plate when photographing. The period of exposure is from eighteen seconds to two hours.]

Note read before Academy of Medicine in Ireland.
*Engl. Mech.*, XXXVIII. (1883) p. 279.
*Sci.-Gossip*, 1884, p. 17.

**Dinner, Microscopists at.**

[Facetious account of a mythical dinner at which "every article of food was carefully examined."]

*The Microscope*, III. (1883) p. 233.

**DIPPEL, L.**—Ein verstellbares Zeichenpult. (An adjustable drawing desk.)

[Reported as from *Lab. Hist. Collège de France*, 1883, p. 188, instead of 1879. [See Vol. III. (1883) p. 565.]

*Bot. Centralbl.*, XVII. (1884) pp. 62–3 (2 figs.).

**Eye-pieces**, Report of the Committee on.

[Vol. III. (1883) p. 711.]

*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 175–7.
Discussion, pp. 238–9.

**FISCHER, G.**—Ueber einige Versuche zur Hebung der Chromatischen Aberration dioptrischer Fernrohre. (On some attempts to remove the Chromatic Aberration of dioptric Telescopes.)

[Contains an abstract of S. Merz's article "Ueber Dispersionsverhältnisse optischer Gläser" (Vol. II. (1882) p. 565), with additional remarks. Also report of letter from K. W. Zenger on his Endomersion Objectives, *ante*, Vol. III. (1883) p. 596, and *post.*]

*Central-Ztg. f. Optik u. Mech.*, IV. (1883) pp. 265–7.

**GRIMM, J.**—See Cohen, E.

**HAGER, H.**—Le Microscope. Théorie et Application. (The Microscope. Theory and application.) Translated from the 4th German edition with annotations by L. Planchon and L. Hugounenq. Introduction by J. E. Planchon. x. and 264 pp., 350 figs. 18mo, Paris, 1884.

**HAMMOND, A.**—Address on resigning the chair of the Postal Microscopical Society.

[Account of the notes written by members of the Society on the slides circulated.]

*Journ. of Microscopy*, III. (1884) pp. 7–17.

**HILGARD, Prof.**—See Micrometer Scale.

HITCHCOCK, R.—Notes from Abroad.
[Ross & Co.'s establishment and Dr. Schröder. Messrs. R. & J. Beck. Mr. Crouch. Powell & Lealand. Swift & Son. Swift's Achromatic Condenser (2 figs.). Swift's Wale's Stand (1 fig.).]
*Amer. Mon. Micr. Journ.*, IV. (1883) pp. 226–9 (3 figs.).

,, ,, A new Camera Lucida.
[Dr. H. Schröder's, Vol. III. (1883) p. 813.]
*Amer. Mon. Micr. Journ.*, IV. (1883) p. 230.

,, ,, The Army Medical Museum.
[As to Dr. Woodward's retirement.]
*Amer. Mon. Micr. Journ.*, IV. (1883) pp. 236-7.

,, ,, Testing a Microscope.
[Directions for testing (1) the centering of objectives, (2) the binocular.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 7–8.

,, ,, A simple Eye-piece Indicator.
[A hair attached to the diaphragm of the eye-piece and extending half-way across the field of view.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 8–9.

,, ,, Bulloch's improved "Biological" stand.
[Improved substage. *Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 9–10.

,, ,, Microscopical Societies.
[Recommending practical demonstrations like those of the Quekett Microscopical Club.]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 16.

See also Tolles, R. B.

HOLMES, E.—Drawing from the Microscope.
[Remarks on E. T. D. *supra*, and suggesting that with the neutral tint reflector "he has but to turn his slide over, i.e. cover downwards on the stage, to make his outlines, and then put his slide right way up when he fills in his detail freehand."]
*Sci.-Gossip*, 1884, pp. 17–18.

HOLMES (O. W.) Dr., and the Microscope.
[In a recent speech, in illustrating the microscopical facilities of the Harvard Medical School, he said :—"A man five feet high, enlarged to correspond with the Microscope power used, would be a mile high, would weigh 120,000,000,000 lbs., and could pick up the Boston State House and chuck it into the sea, cleaning out that ancient structure by a summary process which would put to shame the exploits of Commodus and his kind."]
*Micr. News*, III. (1883) p. 340.

HUGOUNENQ, L.—See Hager, H.

JAMES, F. L.—The Fakir and his little Fakes.
[I. Warning against using silver-plating fluid sold by street venders as it disintegrates the brass of objectives ; formula for a good fluid. II. Anecdote of a street vendor of Microscopes who showed paste eels as animalcules in water.]
*The Microscope*, III. (1883) pp. 193–7.

KOHL, G.—Boecker s neuer Zeichen-Apparat nach Dippel. (Boecker's new Drawing Apparatus after Dippel.) [*Supra*, p. 119.]
*Bot. Centralbl.*, XVI. (1883) pp. 385–6 (1 fig.).

L.—Bicentenary of Bacteria.
[Suggests that the Royal Society should celebrate it by urging on the Government the formation of a national laboratory of hygiene.]
See also Cohn, F., *supra.*
*Nature*, XXIX. (1883) p. 154.

LIPPICH, F.—Vorschlag zur Construction eines neuen Spectral-apparatus. (Proposal for the construction of a new spectral apparatus.)
[Contains a description of an "Astigmatic Mikroskop-Ocular," consisting of two cylindrical and two plano-convex lenses, for use with a spectroscope.]
*Zeitschr. f. Instrumentenk.*, IV. (1884) pp. 1–8 (2 figs.).

**MANSFIELD**, J. M.—Division of labour among microscopists. [*Post.*]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 43–5.
Discussion, pp. 231–2.

**MATTHEWS'** (J.) Simple Revolving Table.
[Two perfectly flat wooden boards, placed face to face, the upper one turning on a pivot in the centre of the lower. The lower board should have some rubber on its under surface, or some material which will cause it to remain in position on a table while the upper one is caused to revolve.]
*Amer. Mon. Micr. Journ.*, IV. (1883) p. 238.

**Micrometer Scale, A, 1882.**
1. History of the National Committee on Micrometry. By R. H. Ward.
2. Report of the National Committee on Micrometry, and accompanying report of Prof. Hilgard.
3. A study of the Centimetre marked "A," prepared by the U.S. Bureau of Weights and Measures for the Committee on Micrometry. By W. A Rogers.
4. Rules for the control of the standard Micrometer.

*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 178–200.

**"Monachus."**—Microscopic Test Objects. [*Supra*, pp. 140–1.]
*Engl. Mech.*, XXXVIII. (1883–4) p. 341 and p. 431 (1 fig.).

**MOORE**, A. Y.—The Resolution of *Amphipleura pellucida*. A reply to Dr. Detmers.
*The Microscope*, III. (1883) pp. 201–4. (See also pp. 200–1.)

**NELSON**, E. M.—Microscopic Test Objects. [*Supra*, pp. 139–40.]
*Engl. Mech.*, XXXVIII. (1883) p. 324 and p. 386 (3 figs.).

" " On the relation of Aperture to Power in Microscope Object-glasses. [*Post.*]
*Engl. Mech.*, XXXVIII. (1883) pp. 367–8.

**NUNN**, R. J.—The Microscope in Medical Gynecology.
["For clinical microscopy no great depth of learning nor an intimate acquaintance with fine-spun theories is required, but a plain practical knowledge of the names and appearance of a few of the forms which the Microscope reveals. It is not necessary to know what everything seen in the Microscope is; it is sufficient to know what it is not. Just as it is not necessary to be an accomplished botanist to distinguish an oak tree from a turnip, or to be a deeply learned naturalist to tell a horse from a goat, so it is unnecessary to be a thorough pathologist to be able to make good use of the Microscope for clinical purposes."]
Sep. repr. from *Trans. Med. Assoc. Georgia*, 1883, pp. 8–10.

**PENNY**, W. G.—Theory of the Eye-piece. I. The Dispersion of Light. II. Dispersion of Light. Also criticisms by J. A. C. III. Spherical Aberration.
*Engl. Mech.*, XXXVIII. (1883) p. 283 (1 fig.), p. 367 (1 fig.), p. 390 (1 fig.).

**PFAFF'S** Mikrogoniometer.
*Hoffmann's Bericht u. d. Wiss. App. a. d. Londoner Internat. Ausstell.* 1876 (1881) pp. 435–6 (1 fig.), p. 738.

**PLANCHON**, J. E.—See Hager, H.

**POULSEN**, V. A.—Botanical Micro-chemistry. Translated with the assistance of the author, and considerably enlarged by W. Trelease. [*Supra*, p. 91.] xviii. and 118 pp., 8vo., Boston 1884.

**POWELL**, Hugh, Death of.
*Engl. Mech.*, XXXVIII. (1883) p. 279, from *Times*, Nov. 1883; *Sci.-Gossip*, 1884, p. 17; *Journ. of Science*, VI. (1884) p. 51.

**"Prismatique."**—Object-glass working, IX. and X.
*Engl. Mech.*, XXXVIII. (1883–4) p. 296 (1 fig.), pp. 420–1.

**REZNER**, W. B.—See Vorce, C. M.

**ROGERS**, W. A.—A critical study of the action of a diamond in ruling lines upon glass. [*Supra*, p. 126.]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, 1883, pp. 149–65.

" " See Micrometer Scale.

**STOKES**, A. C.—A Growing-cell for minute Organisms. [*Supra*, p. 122.]
*Sci.-Gossip*, 1883, pp. 8–9 (1 fig.).

Stowell, C. H. and L. R.—A new Microscopical Journal.
['Science Record.'] *The Microscope*, III. (1883) p. 223.

" " Fasoldt's Micrometers.
[Micrometer which showed Newton's rings in a beautiful manner; also a newly ruled micrometer, each alternate line being ruled longer, so that the end of each band is half the value of the band proper; that is, if the band was in the field ruled 50,000 to the inch, then the end of that band would show 25,000 to the inch. Therefore, as Mr. Fasoldt says, "one can easily judge if there is any diffraction."]
*The Microscope*, III. (1883) p. 239.

" C. H.—A Microscopic Inflation.
[Facetious rejoinder to Dr. O. W. Holmes' statement, *supra*, as to the size of an enlarged Harvard student.]
*The Microscope*, IV. (1883) pp. 10–11.

" " See Tolles, R. B.

T. T.—Microscopic Test Objects.
[Points out the error in E. M. Nelson's suggestion, *supra*, p. 139, that objectives should not be tested by oblique light.]
*Engl. Mech.*, XXXVIII. (1884) p. 386.

" Relation of Aperture to Power in Microscope Object-glasses.
[Reply to E. M. Nelson, *supra*, showing the wide difference between his figures and those of Prof. Abbe.]
*Engl. Mech.*, XXXVIII. (1884) p. 410.

Tetlow, D.—Microscope. U.S.A. Patent, No. 287978, of 24th August, 1883.

Tolles, R. B., Death of. *Boston Evening Transcript*, 28th Nov., 1883.
*Engl. Mech.*, XXXVIII. (1883) p. 336.
*Science*, III. (1883) p. 726.
[" Mr. Tolles has been long known for the construction of Microscopes and Telescopes of unusually short focus. He made the highest-power Microscope produced in America " !] *Athenæum*, 1883, p. 819.
*Micr. News*, IV. (1884) p. 25.
*The Microscope*, IV. (1884) pp. 3–4 (T. Barlow); pp. 4–5 (C. H. Stowell); pp. 5–6 (G. E. Blackham).
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 10–11 (S. Wells and R. Hitchcock).
*Micr. Bull.*, X. (1883) pp. 5–6.
*Science Record*, II. (1883) p. 43.

" " See Detmers, H. J.

Törnebohm, A. E.—Ueber eine Vorrichtung an Mikroskoptischen zur allgemein gültigen Fixirung eines bestimmten Punktes in einem Präparat. (On an arrangement of the microscope-stage for the universal fixing of a given point in a preparation.) [*Post.*]
*Neues Jahrb. f. Mineral.*, 1883, I., pp. 195–6.

Trelease, W.—See Poulsen, V. A.

Vorce, C. M.—A Memoir of W. B. Rezner.
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 242–5.

Walmsley, W. H.—Photo-micrography with dry-plates and lamplight.
[Vol. III. (1883) p. 556.]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 59–64 (1 fig.).

Ward, R. H.—See Micrometer Scale.

Wells, S.—See Tolles, R. B.

Whiting, Sarah F.—College Microscopical Societies.
[Advantages of such societies, and how they can be made a success.]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 27–31.
Discussion, pp. 225–7.

Wright, L.—Lantern and Limelight matters.
[Comparative optical conditions of wick'd lamps and the limelight—Condensers—Lime-jets.]
*Engl. Mech.*, XXXVIII. (1883) pp. 343–4 (2 figs.).

Zenger, K. W.—See Fischer, G.

### β. Collecting, Mounting and Examining Objects, &c.

**Mounting and Photographing Sections of Central Nervous System of Reptiles and Batrachians.***—Dr. J. J. Mason describes the methods he employed in mounting the sections from which the plates illustrating his book † were "artotyped."

"Both the brain and spinal cord were entirely separated from the body, and, with their membranes, placed in iodine-tinted alcohol until they had acquired a slight degree of consistency—from six to twelve hours. They were then transferred to a 3 : 100 solution of bichromate of potash, with a small piece of camphor, in a tightly corked wide-mouthed bottle, and allowed to remain until ready for cutting, renewing the solution every two weeks.

The time required for the hardening process varies considerably in different animals, and this variation is more dependent upon the class of animal than upon the relative dimensions of the specimens.

For example: on the same day I placed the brain of a large rattlesnake with that of a small salamander in the same bottle, and at the end of six weeks the former was ready for section, whilst the latter was not sufficiently hard until a month afterwards. By thus employing the same reagent in all cases, I have been able to note constant differences in the action of both the hardening and the colouring agent, carmine.

Perhaps the most striking illustration of this is furnished by the nervous centres of tailed batrachians, which, while they stain very readily, invariably require about a third more time to harden than specimens from the other orders. Specimens from ophidians stain less satisfactorily than those from any other of the classes which I have studied, while with the spinal cords of alligators, turtles, and frogs failure to obtain good results in this particular is very rare.

In all cases the sections have been stained after cutting, injury from excessive handling being wholly avoided by the use of siphon-tubes to remove the alcohol and washings. For producing transparency, oil of cloves has been used, and the mounting has been done under thin, clear covers, in a solution of Canada balsam in chloroform.

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* 'Minute Structure of the Central Nervous System of certain Reptiles and Batrachians of America,' 1879-1882. Cf. iii. (1883) p. 910.

† "The methods of histology have reached a perfection which is building up new departments of knowledge, and among successful pioneers in these labours Dr. Mason will always hold an honoured place for the technical skill with which he brings the reader face to face with the revelations of his Microscope, and for the sumptuousness with which his work is given to the world. No such monograph has previously come under our notice, for the illustrations of a difficult research leave nothing to be desired. . . .

"No words could do justice to the beauty of the plates or the value of the information they convey; and it is not too much to regard this work as opening a new era in research by substituting knowledge of facts of microscopical structure for their interpretation by the hand of artist or author; but we can scarcely hope to see many books so beautifully illustrated. The author's method has the merit of inaugurating a comparison of the minute anatomy of the nervous system by enabling the reader to see the structures which he has discovered as he saw them; and hence the book will always be a valuable work of reference; and it will certainly induce others to hand on the torch of knowledge in a like excellent way."—From Bibliographical Notice in Ann. and Mag. Nat. Hist., xii. (1883) pp. 270-4.

All the negatives have been made on glass thoroughly cleaned and lightly coated with a solution of wax and benzole, so that the collodion film, previously made adherent to thin sheets of gelatine, could be safely removed from the plate. The flexible negatives thus obtained are well adapted to the artotype process, and, as they can be indefinitely preserved between the leaves of an ordinary scrap-book, are very desirable for a series of illustrations. In making the original negatives on glass, the 'wet collodion process,' with the sulphate of iron developer, has been exclusively employed.

The prints correspond exactly with the negatives, both in outline and detail. No distortion occurs as in silver printing, in which process the paper is subjected to prolonged washing.

In many of the photographs the grey substance appears lighter in shade than the white substance. This appearance is due to a greater degree of transparency of the grey substance in these sections, resulting from the action of the oil of cloves, followed by an increased action of the transmitted light on the sensitive collodion film of the negative, and hence by a thinner deposit of ink over corresponding parts of the positive plates from which the artotypes are printed."

With regard to the process employed, Dr. Mason says that after experimenting with various methods he found that satisfactory prints could be made in ink directly upon plate paper, and that these impressions were as perfect in fine detail as any of those obtained by the silver process of printing. The plates (all printed by the artotype process) are as durable as steel engravings. "While a photograph cannot often show all that can be discovered by more direct microscopic observation with a judicious working of the fine adjustment, high authority has stated, and perhaps correctly, that a good photograph with a low power—say from 3 to 1/2 in.—is a better means of illustrating the anatomical structure of the nervous tissues than hand drawing. Some of the plates with high powers leave much to be desired both in distinctness and tone, and in general it may be affirmed that the same defect as regards distinctness always exists, and for obvious reasons, in photographs of sections with powers much above 1/2 in. In fact it now appears to be established that immersion objectives can never be employed for photographing section-preparations with the success that has attended their use for blood corpuscles, diatoms, and similar specimens."

**Preparing Spermatozoa of the Newt.***—G. F. Dowdeswell writes that to prepare the spermatozoa of the newt for the examination of the minute barb discovered by him, the first essential is to get them as nearly as possible in contact with the cover-glass and flat upon it; this requires some care to avoid their drying, by which they are materially altered. They may be preserved by several methods, either by treating for twelve to twenty-four hours with a concentrated solution of picric acid, a dilute solution of chromic acid, by Dr. Klein's method with a 5 per cent. solution of ammonium chromate, by iodine, by silver nitrate, or by osmic acid or gold chloride; the latter are convenient as being quicker. He has most usually employed picric acid. For staining glycerine, magenta* is the best method, as it stains all parts as strongly as desired. To show the general structure alcoholic carminate of ammonia is the most satisfactory, but it does not stain the barb deeply. Other anilin dyes have not been found to answer so well.

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* Quart. Journ. Micr. Sci., xxiii. (1883) pp. 336–9 (1 fig.).

The use of glycerine as a mounting fluid for preparations stained with any of the anilin dyes is at best troublesome,† and sooner or later, in the author's experience, the staining runs and the preparation is spoiled. Solutions of acetate of potash or chloride of calcium have not been found satisfactory, the forms, even of such resistant objects as bacteria, in some cases becoming materially altered by these reagents. With Canada balsam, even when dissolved in chloroform or turpentine, the preparations have not been found to fade, as has sometimes been said to be the case, and as we should have expected; nor, if they are sufficiently washed in alcohol and passed through oil of cloves, will they run. The risk, however, of both fading and running may be entirely obviated by using benzine as a solvent for the balsam, or by employing it undiluted and liquefied by warmth.

**Killing Hydroid Zoophytes and Polyzoa with the Tentacles extended.**‡—H. C. Chadwick recommends the polyzoon to be placed in a small beaker or clear glass bottle, and allowed to remain at rest for several hours. Now take a dipping-tube drawn out to a very fine point and charge it with absolute alcohol. Having ascertained by means of a pocket-lens that the polypides are fully extended, allow the alcohol to drop very gently from the point of the tube, which should be held just above the surface of the water. The success of the experiment depends largely upon the care with which the first quantity of alcohol is introduced into the water. After the lapse of an hour, if the polypides are still extended, a further quantity of alcohol is added until the quantity reaches 60 per cent.

After passing through 75 per cent. alcohol, the specimens may be kept in 90 per cent. of the same until required for mounting. Experiments with alcohol upon hydroid zoophytes were not so successful, but Kleinenberg's picrosulphuric acid solution§ gave excellent results. The use of this reagent is attended with much less difficulty than that of alcohol. If the subject of the experiment is a zoophyte, such as *Aglaophenia pluma* or *Plumularia setacea*, it must be allowed to remain some hours until the polypides are fully extended. Kleinenberg's fluid must then be introduced by means of a dipping-tube. It may be allowed to flow over the specimen in a continuous stream, until the whole of the water assumes a golden yellow colour. The reagent causes instant death, so that the specimens may be transferred immediately to 60 per cent., and afterwards to 75 per cent. alcohol, allowing them to remain in each solution for some hours. Keep in 90 per cent. alcohol. From four to six minutes' immersion in Martindale's picrocarmine staining fluid is sufficient to stain specimens killed by either of the above methods.

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* Magenta cryst. 1 part; glycerine 200 parts; alcohol 150 parts; aq. 150 parts; immerse the preparation in the solution for from two to four minutes, according to the depth of colouring required, and then wash.

† The method is, add an equal bulk of glycerine to the aqueous solution of the anilin dye used, stain somewhat more deeply than requisite, mount on slide with cover-glass in the staining fluid, which is to be gradually replaced as the water evaporates by plain glycerine.

‡ Micr. News, iii. (1883) pp. 333-4.

§ Cf. this Journal, ii. (1882) p. 867.

**Mounting Pollen as an Opaque Object.***—W. Blackburn gives directions for mounting pollen dry upon the anther from which it has escaped. For collecting and drying the anthers, the flowers should be gathered when full-blown, just before they begin to fade, and the stamens then cut with fine scissors a short distance from the anthers, the latter being allowed to fall upon clean writing paper, when a selection may be made with a pocket-lens of the specimens most suitable for preservation. Folding the paper without pressure, place the packet in a box, where the author lets it remain in oblivion for twelve months or perhaps two years. In the case of large anthers, such as the *Lilium auratum*, it may be advisable to lay them on a piece of blotting-paper, inside the writing-paper, in order the better to absorb moisture, care being taken when mounting, to remove any adhering fibres of the blotting material with a needle.

Thin metal and bone cells may be used for mounting. The metal ones may be either of brass or block tin. For small anthers, such as those of *Ranunculus aquatilis*, the ordinary 1/2 in. brass cells are suitable. For larger anthers, or groups of stamens and anthers, such as may be made from the *Abutilon*, 5/8 in. and 3/4 in. bone cells are the best. Bone is much preferable to metal for its adhesive capacity when affixed to glass, and the bone cells usually sold have their surfaces " truer " than those of metal. For cement use " quick-setting " gold size.

When about to mount the anthers, paint the bottom of the cell with "matt-black," using the turntable, so as to distribute it evenly over the glass. When the " black " is partially dry, place the anthers upon it in suitable positions, and gently press them with a blunt needle so as to secure their adhesion to the cement. The best effect will be produced when the anthers are arranged in the centre of the cell with the stamens directed on one side, as in their natural position. This, however, may be left to the taste of the mounter; and in many cases no arrangement of this kind will be required, as one or other will be found large enough to fill the cell. When there is found to be a deficiency of pollen on any of the anthers after mounting, some pollen may be taken on the point of a needle from other anthers and placed in position on the bare parts, when gently breathing upon it will fix it.

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* Micr. News, iii. (1883) pp. 297-9.

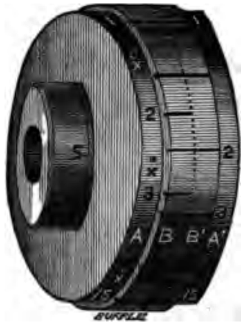
**Mounting Fluid for Algæ.**[*]—For preserving the cell-contents and the natural colour and form of desmids, volvox, and other algæ, G. W. Morehouse finds a mounting fluid made as follows to act well: Dissolve 15 grains of acetate of copper in a mixture of 4 fluid ounces of camphor water, 4 fluid ounces of distilled water, and 20 minims of glacial acetic acid; add 8 fluid ounces of Price's glycerine, and filter. When sections of plant-stems, or other vegetable specimens, are mounted in this fluid, the protoplasm is preserved. If, in any case, it is thought desirable to increase or diminish the specific gravity of the preservative, the proportion of glycerine may be changed. Used as above, or modified as indicated, he thinks it also a trustworthy medium for mounting infusoria and the softer animal tissues.

**Mounting Diatoms in Series.**[†]—P. Francotte has applied Giesbrecht's method [‡] of mounting sections in series to the mounting of diatoms. The slide is coated with the solution of shellac in alcohol washed over with oil of olives or creosote, and the diatoms, previously placed in absolute alcohol, arranged in order. The slide is then warmed, and the oil of cloves or creosote evaporated.

Schällibaum's process [§] for sections would also be available for the same purpose.

**Registering Micrometer-screw to the Thoma Microtome.**[‖]—Dr. C. O. Whitman gives the following more detailed description of this screw, which we described at pp. 914–5 of vol. iii. (1883) from the original article of Andres, Giesbrecht, and Mayer, the designers of the arrangement for regulating its movement. This arrangement consists of a spring which, after a given number of divisions of the drum, registers to the ear and finger of the manipulator the number of micromillimetres which the object has been raised. The intervals between the registering clicks can be varied by means of a vernier-like adjustment of the two halves of the drum, so as to equal an entire revolution of the drum, or only 1/15, 1/3, or 1/2 of a revolution.

Fig. 27.



An examination of fig. 27, which illustrates the new form of the drum, will show how the intervals are regulated. The drum is composed of two symmetrical halves, A B and A′ B′, so closely opposed that the dividing line (dotted in the figure) is scarcely visible. The periphery of each half is composed of two zones of unequal radii. The large zones, B and B′, are in apposition, and together form the graduated portion of the drum. Each of the smaller zones is marked with the figures 1, 2, 3, and 15. When the drum is in order for work, it rotates with the screw, which is marked *g g* in fig. 53, vol. iii. (1883) p. 302.

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[*] Amer. Mon. Micr. Journ., iv. (1883) pp. 234–5.

[†] Bull. Soc. Belg. Micr., x. (1883) pp. 43–8.

[‡] See this Journal, ii. (1882) p. 888.

[§] See this Journal, iii. (1883) p. 736.

[‖] Amer. Natural., xvii. (1883) pp. 1313–4 (1 fig.).

The left half of the drum A B is held in position by the screw S, and may be rotated independently of the right half A′ B′, or of the screw *g g*, by the aid of a handle which fits the holes *x x x*.

When the half A B is adjusted to the half A′ B′, in the manner represented in the figure, the fifteen equal parts into which the zone B is divided exactly correspond to the same number of parts in the zone B′, so that the grooves which mark these parts in one zone, become continuous with those of the other zone. Thus adjusted, the spring, which rides on the zones B B′, with a sharp edge parallel to the grooves, will give fifteen sharp clicks in the course of one rotation of the drum, the click being heard every time the sharp edge falls into coincident grooves. In order to adjust for fifteen clicks, it is only necessary to rotate A B until groove 15 becomes continuous with groove 15 of the opposite half (A′ B′). For one click in one rotation, the grooves 1, 1 must be made to coincide; for two clicks the grooves 2, 2, and for three clicks the grooves 3, 3. The intervals between successive clicks may thus be made to correspond to 1/1, 1/2, 1/3 or 1/15 of a complete rotation of the drum, and the thickness of sections corresponding to these intervals should be respectively ·015, ·0015, ·005, ·001 mm.

ACHESON, G.—Biological Study of the Tap Water in the School of Practical Science, Toronto.
[Methods of examination—Diatomaceæ—Desmidiaceæ—Phycochromaceæ—Schizophytæ—Protozoa—Vermes—Arthropoda.]
*Proc. Canad. Institute*, I. (1883) pp. 413–26 (1 pl. to follow).

ADY, J. E.—Microscopical Technology. On the exhibition (*sic*) of Canada Balsam.
[Directions for mounting sections of tissues in Canada balsam.]
*Sci.-Gossip*, 1884, pp. 5–8.

ADY'S (J. E.) New Morphological Institution [for the production of micrographical preparations, and especially of rock and mineral sections].
*Sci.-Gossip*, 1883, pp. 276–7; 1884, p. 18.
See also *Nature*, XXIX. (1884) p. 283.

AMI, H. M.—Use of the Microscope in determining Fossils, with especial reference to the Monticuliporidæ. *Science*, III. (1884) pp. 25–6.

AYLWARD'S (H. P.) Pond-life Apparatus. [Vol. III. (1883) p. 911.]
*Sci.-Gossip*, 1883, p. 276.

BARRÉ, P.—Sur un procédé de préparation synoptique d'objets pulvérulents. Diatomées des guanos, terres fossiles, &c. (On a process of synoptic preparation of pulverulent objects. Diatoms from guano, fossil earths, &c.)
[*Post.*] *Bull. Soc. Belg. Micr.*, X. (1883) pp. 16–8 (1 pl.).

BELFIELD, W. T.—The Microscope in the detection of Lard Adulteration.
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 97–103 (1 pl.).

BENNETT, C. H.—Mounting Entomological Slides.
[Treat the object for a week or a month, as the case may require, with liq. potassæ until thoroughly bleached; then, without removing the contents of the cavities, or in any way subjecting to the slightest pressure, mount in glycerine in a cell of ample depth so as to allow the object to retain its natural form and position.]
*The Microscope*, III. (1883) p. 220.

BRAMAN, B.—Microscopic Evidence of the Antiquity of Articles of Stone.
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 14–5.

**Brooks'** (H.) Sets of sections of Woods for instruction in schools.
["The sections are about 2 × 4 in., and are neatly mounted between plates of mica. Three sections (one cross and two longitudinal) are given for each kind of wood, and these are thin enough to make their study with the naked eye or with a low power very easy and instructive."]
*Amer. Natural.*, XVII. (1883) p. 1285.

**Burrill**, T. J.—Preparing and mounting Bacteria.
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 79–85.
" " To stain *Bacillus tuberculosis.*
["Many ways have been tried to leave the alcohol out and yet obtain a stain as good as that of the published formulas. The following seems to be the thing sought:—Glycerine, 20 parts; fuchsin, 3 parts; anilin oil, 2 parts; carbolic acid, 2 parts."—Also directions for use.]
*The Microscope*, IV. (1884) pp. 6–8.

**Carpenter**, W. B.—Remarks on Microscopical Observation.
*Syllabus of Carlisle Microscopical Society*, 1884.
*Micr. News*, IV. (1884) pp. 23–4.

**Chadwick**, H. C.—On some experiments made with a view of killing Hydroid Zoophytes and Polyzoa with the tentacles extended. [*Supra*, p. 151.]
*Micr. News*, III. (1883) pp. 333–4.

**Chester**, A. H.—A new method of Dry Mounting.
[Vol. III. (1883) p. 737.]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 143–5 (1 fig.).

**Cheyney**, J.—The Microscopic Study of Fibres.
[The Microscope in the dye-room—The marks of perfect dyeing—Marks of imperfect dyeing—The location of defects.]
*Micr. News*, IV. (1884) pp. 7–9, from *Textile Record of America.*

**Cole**, A. C.—Popular Microscopical Studies.
No. III. The Scalp. Vertical Section of Human Scalp. Double-stained. Plate 3 × 25. pp. 11–14.
No. IV. The Ovary of a Poppy. Transverse section of Ovary of *Papaver rhœas* (unfertilized). Plate 4 × 50. pp. 15–20.
No. V. A Grain of Wheat. pp. 21–4. Plate 5. Long. sec. of Embryo at base of wheat-grain. Stained carmine. × 50.
" " The Methods of Microscopical Research. Part V. The Preparation of Animal Tissues (*continued*). pp. xxv.–xxxii. (2 figs.).
[Silver nitrate—Chloride of gold—Injection of Blood-vessels (Injecting Apparatus, Fearnley's Constant Pressure Apparatus).]
Part VI. pp. xxxiii.–xl. How to preserve Botanical specimens. On Animal and Vegetable Section-cutting. Rutherford's, Williams', Fearnley's and Cathcart's Microtomes. Gum and syrup preserving fluid. To cut tissues soaked in gum and syrup medium. Cutting by imbedding.
" " Studies in Microscopical Science.
Vol. II. No. 7. Section 1. No. 4. Epithelium. pp. 13–16. Plate 4, × 400.
No. 8. Section 2. No. 4. Chap. II. The Cell as an Individual. pp. 13–16. Plate 3 (*Micrasterias denticulata* × 200).
No. 9. Sec. 1. No. 5. Cartilage. pp. 17–19. Plate 5. T. S. Hyaline Cartilage. Human Trachea × 250.
No. 10. Section 2. No. 5. Chap. III. The Morphology of Tissues. pp. 17–20. (Plate to follow.)

**Dowdeswell**, G. F.—Note on a minute point in the structure of the Spermatozoon of the Newt.
[Contains directions for preparing the spermatozoa, *supra*, p. 150.]
*Quart. Journ. Micr. Sci.*, XXIII. (1883) pp. 336–9 (1 fig.).

**Francotte**, P.—Description des différentes méthodes employées pour ranger les coupes [et les Diatomées] en série sur le porte-objet. (Description of the different methods adopted for mounting sections [and diatoms] in series on the slide.)
[Description of Mayer's, Giesbrecht's, Schällibaum's, and Threlfall's methods; also the application of the second and third to diatoms, *supra*, p. 153.]
*Bull. Soc. Belg. Micr.*, X. (1883) pp. 43–8, 63–6.

**Francotte**, P.—Microtomes et méthodes d'inclusion, I. (Microtomes and methods of imbedding.)
[Describes Thoma's Microtome and various methods already published.]
*Bull. Soc. Belg. Micr.*, X. (1884) pp. 55–63 (1 fig. and 1 pl.).

**Freeman**, H. E.—Cutting Glass-circles.
[Perforated wooden slips and writing diamond with *turned* point, the thin glass to rest on plate-glass; very little pressure on diamond; it is better to leave the circles a day or two before breaking them out of the glass.]
*Journ. of Microscopy*, III. (1884) p. 47.

G., W. B.—Cement for objects mounted in spirits of wine.
[Same as *ante*, Vol. III. (1883) p. 613. The cement a "secret."]
*Midl. Natural.*, VI. (1883) p. 282.

**Gage**, S. H.—Cataloguing, labeling, and storing Microscopical preparations.
[Vol. III. (1883) p. 924.]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, 1883, pp. 169–74 (2 figs.). Discussion, pp. 236–8.

" " and **Smith**, T.—Serial Microscopic Sections. [*Post.*]
*Medical Student* (N.Y.) I. (1883) pp. 14–6.

**Gilliatt**, H.—Some remarks on the action of Tannin on Infusoria.
[Vol. III. (1883) p. 861.]
*Proc. Linn. Soc. N. S. Wales*, VIII. (1883) pp. 383–6.

**Grant**, F.—Microscopic Mounting.

IV. Section Cutting, Staining, &c.
[1. Sections. 2. Section Cutting. 3. Staining. 4. Various practical details.]
*Engl. Mech.*, XXXVIII. (1883) pp. 285–6.

V. The Use of Reagents.
[1. The use of Reagents in general. 2. Glycerine and Syrup. 3. Acids and Alkalis.]
*Engl. Mech.*, XXXVIII. (1883) pp. 365–7.

VI. Chloroform.—Vegetable Objects.
[1. Chloroform or Benzol, for thinning Canada balsam. 2. Non-fructifying organs of higher plants. 3. Ways in which vegetable sections should be cut. 4. Bleaching. 5. Staining.]
*Engl. Mech.*, XXXVIII. (1884) pp. 386–8.

VII. Staining.
[1. Staining in general.—Transient stains. 2. Metallic impregnations.—Diffuse, bioplasmic, and special tissue stains. 3. Hæmatoxylin and Carmine. 4. Indigo Carmine, Aniline, and Phthalein stains. 5. Double staining.]
*Engl. Mech.*, XXXVIII. (1884) pp. 449–50.

**Griffith**, E. H.—Practical Helps.
[Ringing slides—Photograph slides—Mounts without covers—Arranging Diatoms, *post.*]
*The Microscope*, III. (1883) pp. 204–6.

H., H.—Microscopic Mounting.
*Engl. Mech.*, XXXVIII. (1883) p. 266.

**Haacke**, W.—Ueber das Montiren von Alcoholpräparaten. (On the mounting of alcohol preparations.)
[For microscopic objects for Museums.] *Zool. Anzeig.* VI. (1883) pp. 694–5.

**Hamlin**, F. M.—The microscopical examination of seminal stains on cloth.
[Describes a new process, as "Koblanck's method, with its soakings and manipulations, tends to destroy so many of the spermatozoa as to lessen greatly the certainty of finding them."]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 21–5. Discussion, pp. 220–5.

" " The preparation and mounting of Foraminifera, with description of a new slide for opaque objects. [*Post.*]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 65–8.

Hitchcock, R.—Preservation of Museum specimens.
[Description of the Naples Zoological Station specimens at the Fisheries Exhibition. The living creatures are plunged into a solution of iodine or a strong solution of corrosive sublimate and transferred to dilute spirit, in which they are permanently preserved.]
*Amer. Mon. Micr. Journ.*, IV. (1883) pp. 217–8.

„ „ Exorbitant prices of mounted specimens of microscopic objects in America. *Amer. Mon. Micr. Journ.*, IV. (1883) p. 218.

„ „ Glycerine in Mounting.
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 15–6.

„ „ See Vorce, C. M.

Jacobs, F. O.—How to make a section of Tooth with pulp.
*The Microscope*, IV. (1884) pp. 8–9.

Kellicott, D. S.—Notes on Protozoa. No. 2.
[Agrees with the opinion of H. Gilliatt, III. (1883) p. 861, that the needle-like bodies seen when *Paramecium* is treated with tannin and glycerine are not cilia but trichocysts.]
*Bull. Buffalo Naturalists' Field Club*, I. (1883) pp. 109–17.

Kingsley, J. S.—Rapid Microscopic Mounting.
[Describes Giesbrecht's and Caldwell's methods of series preparations.]
*Science Record*, II. (1883) pp. 1–2.

„ „ Glycerine Mounting.
["One great difficulty in its use is in fastening the cover-glass firmly. Various modes of procedure have been described, possibly the best the writer has seen in print being that which employs paraffin. A still better method is to use a very small amount of glycerine, so little in fact that when the cover is applied the margin of the glycerine does not reach the edge of the glass. Then with a fine brush, balsam or dammar dissolved in benzol is allowed to run in under the edge of the cover-glass, and after becoming hard the superfluous balsam is cleaned off and the slide finished in any desired manner."]
*Science Record*, II. (1883) p. 17.

Könike, F.—Die zweckmässigste Wasser-regeneration der Aquarien mit microscopischen Sachen. (The most effective mode of regenerating the water of Aquaria having microscopical objects.) [*Post.*]
*Zool. Anzeig.*, VI. (1883) pp. 638–9.

Low-Sergeant, W. [*Low-Sarjeant* p. cxxxi—*Low-Sargeant* wrapper].—New process for Preserving Plants. [*Post.*]
*Proc. and Trans. Croydon Micr. and Nat. Hist. Club*, 1882–1883, pp. cii.–iii.

Maggi, L.—Technica Protistologica. Cloruro di Palladio. (Protistological Technics. Chloride of Palladium.) *Bollett. Scientif.*, V. (1883) pp. 48–51.

Mayer, P.—Einfache Methode zum Aufkleben mikroskopischer Schnitte. (Simple method of fixing microscopical sections.) [*Post.*]
*MT. Zool. Stat. Neapel*, IV. (1883) pp. 521–2.

McCalla, A.—President's Address to the 6th Annual Meeting of the American Society of Microscopists. The Verification of Microscopic Observation.
[Vol. III. (1883) p. 766.]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, pp. 1–19.

Morehouse, G. W.—A new Mounting Fluid. [*Post.*]
*Amer. Mon. Micr. Journ.*, IV. (1883) pp. 234–5.

Muller, C. J.—The discrimination of Species of Wood by a microscopical examination of sections of branches.
*Trans. Eastbourne Nat. Hist. Soc.*, I. (1883) pp. 4–12.

Parietti, E.—Ricerche relative alla preparazione e conservazione di Bacteri e d'Infusori. (Researches on the preparation and preservation of Bacteria and Infusoria.)
*Bollett. Scientif.*, V. (1883) pp. 95–6.

**Peticolas'** (C. L.) New Slides of Diatoms.

["Slide No. 1, *Stauroneis acuta.*—Microscopists are familiar with the beautiful effects of dark-field illumination upon certain diatoms. Some peculiarities of structure are shown by this method more clearly than by transmitted light. A recent gathering of *St. acuta* (*Pleurostaurum acutum* Grunow) has given me a sensation, although I have practised this method of illumination for years. With a 1/2 inch objective and a strong artificial light on dark field, this diatom seems literally to blaze, and surpasses in splendour the finest polariscope objects in my cabinet. With the light thrown across the short diameter, there is a strong resemblance to a section of ostrich tendon, only some peculiarity of striation seems to impart motion to the light, and the diatom seems on fire; across the long diameter the colour is changed to a brilliant sapphire.]

*Amer. Mon. Micr. Journ.*, IV. (1883) p. 234.

**Pillsbury**, J. H.—A new Microscope Slide Cabinet. [*Post.*]

*Science Record*, II. (1883) pp. 25–6 (2 figs.).

**Queen**, J. W. & Co.—Improved Slide Box.

[Covered with cloth instead of paper; inside of lid with numbered lines for indexing.]

*Micr. Bulletin*, I. (1883) p. 7 (1 fig.).

**R.**, D.—Classification and Labelling of Microscopical Objects.

[Suggestion that locality should be added to I. C. Thompson's labels, Vol. III. (1883) p. 926.]

*Sci.-Gossip*, 1883, p. 276.

**Ralph**, T. S.—Thymol as a Polariscopic Object.

[A most splendid polariscopic object. If a very small piece, about the size of a mustard-seed (or perhaps two) is placed at the edge of a cover-glass on a slide (not under), and then made to melt, it will run under it in a very fine film and crystallize on cooling. But before this take place, it should be placed on the stage, with the polarizing apparatus ready, so as to watch the process of crystallization. The effects far exceed that of most polariscopic objects. The same specimen carefully remelted can be used over and over again.]

*Journ. of Microscopy*, III. (1884) pp. 31–2.

**Rataboul**, J.—Les Diatomées. Récolte et préparation. I. Récolte des Diatomées. (The Diatomaceæ. Collection and preparation. I. Collection of the Diatomaceæ.) (In part.) *Journ. de Microgr.*, VII. (1883) pp. 644–6 (1 pl.).

**Reinold**, A. W., and A. W. **Rücker**.—Liquid Films and Molecular Magnitudes. [*Post.*] *Proc. Roy. Soc.*, XXXV. (1883) pp. 149–51.

**Renson**, C.—Nouveau procédé de recherche des Trichines dans les Viandes. (New method of research for *Trichinæ* in meat.) [*Post.*]

*Bull. Soc. Belg. Micr.*, X. (1883) pp. 24–25.

**Rothrock**, J. T.—Some microscopic distinctions between good and bad Timber of the same species. *Amer. Phil. Soc.*, Feb. 1883.

**Rothwell's** (W. G.) Educational Slides. *Micr. News*, III. (1883) p. 340.

**Royston-Pigott**, G. W.—Note on the structure of the Scales of Butterflies.

*Trans. Eastbourne Nat. Hist. Soc.*, I. (1883) pp. 41–5.

**Rücker**, A. W.—See A. W. Reinold.

**Schaeffer**, E. M.—The Microscopical Study of the Crystallization of Allotropic Sulphur.

[Contains directions for preparing.]

*Amer. Mon. Micr. Journ.*, V. (1884) pp. 1–3.

**Schnetzler.**—Notiz über Tanninreaction bei Süsswasseralgen. (Note on the reaction of tannin in the fresh-water Algæ.) [*Post.*]

*Bot. Centralbl.*, XVI. (1883) pp. 157–8.

**Scott**, W. B.—Imbedding in Egg-mass.

[Ruge's improvement of Calberla's method. Cf. Vol. III. (1883), pp. 303–4.]

*Science Record*, III. (1883) pp. 41–2.

**Slack, H. J.**—Pleasant Hours with the Microscope.
[Muscular System of Insects.]
*Knowledge*, IV. (1883) pp. 316–7 (2 figs.), 383–4.
„ „ [Trichinæ.] „ V. (1884), pp. 20–1 (2 figs.).
„ „ [Examination of atmospheric dust.]
„ „ pp. 51–2 (3 figs.).

**Stanley's** Stained Sections for use of students.
[In tubes ready for mounting and previous examination, so that students can try the effect of reagents upon them before putting them up as permanent objects. A circular accompanies, detailing the method of mounting and what to observe in the finished slides.]
*Micr. News*, III. (1883) p. 340.

**Taránek, K. J.**—Monographie der Nebeliden Böhmen's.
[Contains a note on preparing Fresh-water Rhizopoda. *Post.*]
*Abh. K. Böhm. Gesell. Wiss.*, XI. (1882) Art. No. 8, iv. and 56 pp. (5 pls.).

**Taylor, T.**—Freezing Microtome.
*Proc. Amer. Assoc. Adv. Sci.*, 1881, pp. 119–21.

**Thoma, R.**—Microtome à glissement et méthodes d'enrobage. (Sliding Microtome and methods of imbedding.)
[Same as *ante*, Vol. III. (1883) p. 298, and *post.*]
*Journ. de Microgr.*, VII. (1883) pp. 576–83 (7 figs.), pp. 639–44 (1 fig.)

**Thompson, I. C.**– Microscope Labels.
[Claim of priority over Mr. Quinn for the labels described Vol. III. (1883) p. 926.]
*Micr. News*, III. (1883) pp. 334–6.

**Thomson, W.**—The size of Atoms.
[*Post.*] *Proc. Roy. Instit.*, X. (1883) pp. 185–213 (11 figs.).

**Vorce, C. M.**—The microscopical discrimination of Blood.
[Six propositions "generally and with rare exceptions true," setting forth the author's "views of micrometry in general in relation to minute objects, including blood."] Also comments by R. Hitchcock.
*Amer. Mon. Micr. Journ.*, IV. (1883) pp. 223–5, 238–9; V. (1884) pp. 17–8.
„ „ Expanding the Blow-fly's Tongue. [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 12.

**W., D. S.**—Washing and mounting objects containing a considerable quantity of air. [*Post.*] *Amer. Mon. Micr. Journ.*, V. (1884) p. 18.

**Ward, E.**—Mounts and Mounting.
[Abstract of the author's 'Microscopical Mounts and Mounting,' and 'Micro-crystallization.']
*Amer. Mon. Micr. Journ.*, IV. (1883) pp. 149–56 (in part).

**West, T.**—"Polariscope objects, with few exceptions, are merely pretty things, well enough calculated, in moderation, to relieve the solid bill of fare at a soirée or conversazione, but nothing whatever is to be learnt from them save that by certain arrangements of apparatus belonging to our Microscopes, some things become decked in gay colours; that is literally all."
[This statement will, we think, be generally recognized as very much too sweeping!—Ed. J.R.M.S.]
*Journ. of Microscopy*, III. (1884) p. 47.

**Whitman, C. O.**—Recent improvements in Section-cutting.
[Contains abstracts of Andres, Giesbrecht, and Mayer's section-smoother, III. (1883) p. 916—The registering micrometer-screw, III. (1883) p. 914 and *supra*, p. 153—The new object-holder, III. (1883) p. 915—An improvement in the carriers, III. (1883) p. 916—Type-metal boxes for imbedding, III. (1883) p. 913.]
*Amer. Natural.*, XVII. (1883) pp. 1311–16 (3 figs.).

**Whitman, C. O.**—Methods of preventing the rolling of microtomic sections.
[Transverse knives, *post.* Schulze's section-smoother (1 fig.) III. (1883) p. 450.]
*Amer. Natural.*, XVIII. (1884) pp. 106–8 (1 fig.).

**Woodward, A. L.**—Unpressed mounting of the Tongue of the Blow-fly.

["While it is an easy matter to catch and decapitate your blow-fly, unfortunately he will not always protrude his tongue properly during the operation, and my experience is that the tongue remains for ever after fixed in the position that it happens to be in when life in the fly becomes extinct. To remedy this, I tried the plan of immersing the living insect in alcohol, and with perfectly satisfactory results. At the moment of death the tongue is forcibly protruded to its entire length. Even the short proboscis of the house-fly is satisfactorily displayed. I tried carbolic acid in the same way, but the results were not nearly so good, and, besides, alcohol is a much nicer fluid to handle."]

*Amer. Mon. Micr. Journ.*, IV. (1883) p. 239.

**Wright, L.**—Microscopical Mounting.

[Impossibility of procuring insect preparations "mounted in a really *first-class* manner," &c.]

*Engl. Mech.*, XXXVIII. (1883) pp. 343-4 (2 figs.).

# PROCEEDINGS OF THE SOCIETY.

MEETING OF 12TH DECEMBER, 1883, AT KING'S COLLEGE, STRAND, W.C., JAMES GLAISHER, ESQ., F.R.S., VICE-PRESIDENT, IN THE CHAIR.

**The Minutes** of the meeting of 14th November last were read and confirmed, and were signed by the Chairman.

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**The List of Donations** (exclusive of exchanges and reprints) received since the last meeting, was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Balbiani, G.—Leçons sur les Sporozoaires. viii. and 184 pp. (51 figs. and 5 pls.). 8vo, Paris, 1883 .. .. .. .. .. | *The Author.* |
| Ferguson, J.—The Microscope, its Revelations and Applications in Science and Art. viii. and 160 pp. 8vo, Edinburgh, 1858 .. .. .. .. .. .. .. .. .. .. .. .. .. | *Mr. Crisp.* |

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**The Chairman** said it was his painful duty to announce that since their last meeting, the death had occurred of one of their number, who during almost the whole of his life had been held in the highest esteem and respect by all microscopists. He referred to Mr. Hugh Powell, of the firm of Powell and Lealand. It was truly a ripe old age to which he had attained, but nevertheless it was always painful when at length the time of parting came, and both as a Society and as individuals, he was sure they must deeply regret the removal of one whom they had always held in such respect. It was by an unfortunate coincidence that it fell to his lot to announce to the same meeting the death of Mr. Powell's most distinguished rival in America, Mr. R. B. Tolles, of Boston, who had also done so much for the improvement of objectives. Peace be to both of them, with the kindliest feelings of sympathy towards their respective families, of every Fellow of the Society.

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**Mr. Crisp** exhibited (1) Mr. H. P. Aylward's Microscope, having a swinging tail-piece rotating completely round the stage, so that the mirror and substage could be set in any required azimuth (p. 110); (2) a Microscope by Mr. A. McLaren, rotating upon the horse-shoe foot, so as to secure greater stability for the instrument when the body was inclined at any considerable angle (p. 111); (3) a Microscope by Herr F. W. Schieck (p. 112), with a number of objects inserted in the circumference of a revolving drum, so that each could be passed in turn beneath the objective. A translation of the inventor's description of the instrument and its advantages was read to the meeting, and his claim to absolute originality shown to be erroneous by the exhibition of Harris's Microscope (p. 115), obviously of considerable age, in which the same idea had been carried out.

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**Mr. W. H. Walmsley's** photo-micrographs were exhibited, two of which in particular (of Möller's diatoms) were characterized by the Chairman as very excellent examples of photo-micrography.

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**Mr. W. M. Bale's** note on Mounting in Glycerine was read.

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**Dr. J. H. L. Flögel's** paper on "Researches on the Structure of Cell-walls of Diatoms" was brought before the meeting by Mr. J. Mayall, jun., who, in his preliminary remarks, said that it would be remembered that some time ago they had heard reports that some one abroad was making sections of diatoms, and he was requested by Mr. Crisp to institute inquiries with the view of bringing the method before the Society. He subsequently found that this work was being done by Dr. Flögel of Holstein, who, there appeared no reason to doubt, was not only a skilled and competent observer, but that he possessed every kind of appliance for making careful observations. Having ascertained this, the next thing was to obtain specimens of actual sections of diatoms, without which it was of course not possible to form any satisfactory judgment on the matter. He was fortunate in persuading Dr. Schröder, now resident in London, to write to Dr. Flögel upon the subject, and in the result they had received a very elaborate paper accompanied by a dozen slides and a number of photographs and drawings in illustration.

A careful examination of the slides showed that Dr. Flögel was thoroughly familiar with the finest processes of mounting, and with all that had been done by Möller. One of the slides was exhibited in the room under a 1/25 in. objective by Mr. Powell. It was a section of *Triceratium favus*, and the excellence of the specimen gave rise to the impression that something even more difficult than this could be accomplished. Amongst the other specimens sent, were some very clean cut sections giving an exceptionally clear image. It was stated by Dr. Flögel that as many as 174 transverse sections had been made of one diatom, all of which could be plainly identified as belonging to the same diatom. Mr. Mayall said that he could not pledge himself as to the correctness or otherwise of the theory set up by the author of the paper, as the subject was not one which he had made his own, although he had taken some pains to translate the paper for publication in the Journal of the Society.

Mr. Mayall then read an abstract of the paper to the meeting, and the subject was discussed by Mr. Curties, Mr. Crisp, and other Fellows.

The Chairman in proposing a vote of thanks to Dr Flögel for his paper, said that he was sure the Society would feel doubly indebted to Mr. Mayall for the exertions which he had made to procure the paper, and also for trouble he had taken in the matter of its translation.

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**The following Instruments, Objects, &c., were exhibited:—**

Mr. Crisp:—

(1) Aylward's Rotating and Swinging Tail-piece Microscope.
(2) McLaren's Microscope with Rotating Foot.
(3) Schieck's Revolver School and Drawing-room Microscope.
(4) Harris's Revolver Microscope.

Dr. J. H. Flögel:—Sections of Diatoms illustrating his paper.
Mr. J. Mayall, jun.:—Ditto.
Mr. T. Powell:—Ditto.
Mr. W. H. Walmsley:—Photo-micrographs.

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**New Fellows**:—The following were elected *Ordinary* Fellows:—Messrs. John Butterworth, W. T. Cleland, M.B., T. B. Rossiter, and Andrew F. Tait.

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## CONVERSAZIONE.

The first Conversazione of the Session was held on the 8th November, 1883. The following objects, &c., were exhibited:—

Mr. H. P. Aylward:
  Set of collecting apparatus.
Mr. Chas. Baker:
  New Mineralogical Microscope by Zeiss.
  Portable Student's Microscope by Leitz.
  Stewart's Safety Stage.
  Test Diatoms in monobromide of naphthaline and phosphorus, by Möller.
Mr. J. Badcock:
  *Ophrydium Eichhornii* and *Fredericella sultana.*
Messrs. R. and J. Beck:
  *Bacillus tuberculosis* in liver of a bird, and *Bacillus Anthracis* in human liver.
Mr. Thos. Bolton:
  *Cordylophora lacustris.*
Mr. W. G. Cocks:
  *Megalotrocha albo-flavicans.*
Mr. F. Crisp:
  Type-Plate of 400 Diatoms, with names photographed, by J. D. Möller.
Mr. G. F. Dowdeswell:
  Spermatozoa of Water Newt (*Triton cristatus*). (1) Showing general structure, with the filament and membrane. × 200 diameters. Powell's 4/10 in. (2) Showing minute barb on point of head of the same. × 3600 diameters. Powell's 1/24 in. homogeneous immersion, N.A. 1·37.
Mr. F. Enoch:
  Various species of minute Hymenoptera.
Mr. F. Fitch:
  Dissection of *Phalangium opilio.*

Mr. H. E. Freeman:

Acarina from a hay-rick.

Mr. J. W. Groves:

*Hydra fusca* and *Amœba* of large size.

Mr. A. de Souza Guimaraens:

Hyphersthene, St. Paul's Island; Porphyritic Melaphyre, Plauen, near Dresden. Stained blue?

Mica Diorite, Freiburg; Mica Diorite, Wölsau, Fichtelgeb.; Quartz Diabase, Gotha; Quartz Diorite, Bingen. The same rock?

Mr. H. Hailes:

Abnormal forms of Foraminifera (*Peneroplis*).

Mr. J. D. Hardy:

Chromatoscope and transverse section of eyelash of Whale.

Mr. J. E. Ingpen:

Cyclosis in Australian *Vallisneria*.

Mr. W. Joshua:

Sea skimmings from the east coast of New Guinea, containing the following species:—*Rhizosolenia styliformis*, *striata*, *alata*, *setigera*, *calcaris*, *Shrubsolii*; *Chætoceras peruvianus* and *Wighamii*; *Coscinodiscus nobilis*, *concinnus*, *radiatus*; *Lauderia annulata*; *Mœlleria caudata*; *Eucampia zodiacus*; *Palmeria Hardmaniana*; *Melosira grandis*, &c.

Dr. Matthews:

Sponge from the base of *Stylaster*.

Mr. J. Mayall, jun.:

Dr. Schröder's Camera Lucida.
„ 1/4 in. Eye-piece.
„ 1 in. do.
McLaren's new Fine Adjustment.

Mr. A. D. Michael:

*Hoplophora magna*. The muscles for raising the cephalothorax, showing the tendonous attachments; and a trachea of *Damæus geniculatus*, showing the spiral structure not before detected.

Mr. E. M. Nelson:

Human Spermatozoon, showing a division in the tail not before observed, with Powell and Lealand's oil-immersion 1/12.

Mr. F. A. Parsons:

*Cerataphis lataniæ*, the Horned Aphis.

Messrs. Powell and Lealand:

Scale of *Podura* with 1/25 oil-immersion, N.A. 1·38.

Mr. B. W. Priest:

Section of *Placospongia melobesioides*, and *Plumularia setacea*, with tentacles expanded.

Mr. S. O. Ridley:

'Challenger' Deep-sea Sponges.

Messrs. Swift and Son:

Small Petrological Microscope.

Mr. G. Smith:

Fossil Wood silicified in section; Dolerite, &c.

Mr. C. Stewart:
  Scale of Lizard (*Cyclodus ?*).
Mr. J. H. Steward:
  Davis's Central Aperture and Iris Diaphragm, and Prowse's Ophthalmoscope.
Mr. Amos Topping:
  Some Vegetable Preparations.
Mr. J. G. Waller:
  Excavating Algæ? in calcareous particles from the Gabbard and Galloper Sands, off east coast of Essex (decalcified).
Mr. H. J. Waddington:
  Examples of Foliated Crystals, polarized Erythrite, Sulphocarbolic acid (?), Kinate of quinine, and Magnesium platinocyanide.

### MEETING OF 9TH JANUARY, 1884, AT KING'S COLLEGE, STRAND, W.C. THE PRESIDENT (P. MARTIN DUNCAN, ESQ., F.R.S.) IN THE CHAIR.

**The Minutes** of the meeting of 12th December last were read and confirmed, and were signed by the Chairman.

**The List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Harting, P.—Recherches micrométriques sur le développement des Tissus et des Organes du Corps humain, précédées d'un examen critique des différentes méthodes micrométriques. viii. and 88 pp. 4to, Utrecht, 1845 | *Mr. Crisp.* |
| Heller, K. B.—Das dioptrische Mikroskop, dessen Einrichtung und Behandlung. vi. and 56 pp. (18 figs.). 8vo, Wien, 1856 | *Mr. Crisp.* |
| Magnin, A., and G. M. Sternberg.—Bacteria. xix. and 494 pp. (30 figs. and 12 pls.). 8vo, New York, 1884 | *Dr. Sternberg.* |
| Set of Collecting Apparatus | *Mr. H. P. Aylward.* |
| Slide of *Microthamnion vexator* (Cooke) | *Mr. W. B. Turner* |

**Mr. Crisp** exhibited and described Mr. Bulloch's new Objective Attachment (p. 118), which he thought was more complicated than was at all necessary, and which on that account could not be considered an improvement on that of Mr. Nelson, or the Matthews-Watson form.

**Mr. John Mayall, jun.**, exhibited and described (1) Mr. Parsons' Current Slide (p. 121), and (2) Nelson's Microscope Lamp, with the oil vessel in the original square form (p. 125), and also with the improved round vessel as suggested by himself. With the exception of the very elaborate and expensive lamp devised by Mr. Dallinger, he considered this to be the best lamp yet produced for microscopical purposes.

Mr. Crisp pointed out that the device made use of in Mr. Parsons' slide was adopted by M. Nachet, some years ago, for adjusting the depth of the cell in counting blood-corpuscles.

**Mr. W. J. Sollas's** letter on the subject of cutting sections of diatoms was formally laid before the meeting. It had reference to the paper of Dr. Flögel, read at the December meeting, and was also intended to be read at that meeting, but did not come to hand until the meeting was over, when it was informally communicated to those present. The letter was as follows :—

"For some time past I have been engaged in cutting sections of diatoms. My plan is to scrape off a green slime from our river mud, consisting chiefly of *Pleurosigma zigzag*—a large species suitable for cutting. The slime, together with some mud, unavoidably gathered at the same time, is placed in a saucer and covered with a piece of muslin, which lies in immediate contact with the mud, while a film of water lies above it. The saucer is now exposed to daylight, and the diatoms creep through the muslin, collecting in a consistent film on its upper surface. The muslin may now be lifted from the mud, it comes away clean bringing all the diatoms with it, but leaving the mud. The muslin with the diatom film is now immersed in the usual hardening and staining reagents. I have used a mixture of chromic and osmic acids and absolute alcohol for hardening; borax-carmine, hæmatoxylin, and eosin for staining. When duly stained and hardened the diatom films may be removed from the muslin without difficulty, and cut, either by imbedding in pure paraffin (melting point 58°) and mounting in Canada balsam, or by freezing in gelatine jelly, which allows one to cut *consistent sections which may be mounted direct in glycerine* on a glass slide, without passing through water. By employing these two processes, I have made out the internal structure of diatoms, and believe that I can detect fine protoplasmic threads proceeding from the protoplasm that surrounds the nucleus and passing through apertures in the median keel. I am not yet, however, in a postion to demonstrate this with absolute certainty, but hope to do so soon."

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**Dr. Beale** gave a resumé of his paper on "The Constituents of Sewage in the Mud of the Thames" (p. 1), illustrating his remarks by numerous drawings, and pointing out the important bearing of the matter upon the question of the health of the population of London in the probably near future.

The President thought the Society would feel greatly indebted to Dr. Beale for bringing before it this very unpleasant subject in a truly scientific spirit. Of its great importance from a sanitary point of view there could be no manner of doubt.

Mr. Bennett said he could confirm from his own experience the view expressed by Dr. Beale, that by no means all of the sewage of London was discharged into the Thames. As an instance in point, he might say that he had lived for some time in the north of London, and had recently discovered that there was no connection between the house and the main drain, but that the house drains merely led to a cesspool. He was told that this was the case with at least half the other houses in the road. He should be sorry to appear to throw the slightest doubt on any point touched upon by Dr. Beale, as of course, when they appeared in print, many of the particulars would be more fully entered upon; but with regard to the spiral vessels of plants found in the mud, and the suggestion that they belonged to cabbage which had passed through the intestinal canal of man, he believed that it was a fact that they were without any work upon the anatomy of the spiral vessels which was at all conclusive upon the subject, or any information which would enable them to discriminate between the spiral vessels of different plants, or between those from different parts of the same plant. Before, therefore, it would be possible to accept the evidence as conclusive, they required some controlled experiments to prove that such things did not exist in water which was free from all suspicion of sewage. The cabbage, as was well known, belonged to an order of plants very common on the banks of the Thames, watercress for example growing there in large quantities, besides which cabbage was an article extremely likely to be thrown overboard from vessels and barges, so that he should be very careful in coming to a conclusion that these spiral vessels necessarily had their origin in the sewage.

Dr. Maddox said that some years ago he made a similar examination of water and mud from a field which had been irrigated with sewage. He took some from the inlet, and the other from a place just below the inlet, and he had not the slightest difficulty in recognising specimens in Dr. Beale's drawings as being of the same kind as those which he found on that occasion. Amongst other things, it was quite easy to identify muscular fibre, some of which was very imperfectly digested, also minute portions of broken shell, but the chief thing which struck him was the great excess of muscular fibre in proportion to the quantity of vegetable matter. There might have been portions of coal, but he did not remember recognizing its structure so clearly as Dr. Beale had done, but it struck him as being a dangerous process to irrigate fields with this kind of refuse, and then to drink the water from streams into which such water drained.

Dr Beale said he quite agreed with Mr. Bennett that it was impossible actually to identify the spiral vessels, but having regard to their identity with those obtained from cabbage, the chief point upon which he laid stress was the very great quantity of them found, in excess of all that could be well accounted for in any other way. Then again, it was well known that the number of vegetables growing upon the banks of the river went on decreasing, whilst the quantity of mud kept increasing. There was one point of interest in connection with the subject which he ought to have mentioned, and that was the marked difference in the death rate of London since the present system of drainage was adopted. In 1870, when the system was first set to work, the rate of mortality was 24·4, and it had since that time decreased, until now it was only 21·4, so there was every encouragement for every one to do his best to get rid of the sewage, or to dilute it still further.

Mr. Crisp referred to a paper by Mr. G. Acheson (Proc. Canad. Inst. i. (1883) pp. 413–26), with fourteen pages of description of organisms found in the tap water of Toronto.

**Col. O'Hara's** communication on some peculiarities of form and independent movement in blood-corpuscles, and a subsequent letter on the subject were read. Photo-micrographs in illustration were also exhibited.

Dr. Maddox said that in Dr. Sternberg's "Photo-micrographs," a blood-corpuscle from a yellow-fever patient was figured which he thought showed the same kind of appearance as that described.

Col. O'Hara also further explained the results of his examination.

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**Mr. Crisp** read a letter from Dr. Van Heurck on the advantage he had found in mounting in styrax, and exhibited the slides which he had sent.

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**Mr. J. P. Bisset's** "List of Desmidieæ, found in gatherings made in the neighbourhood of Lake Windermere during 1883," was taken as read.

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**Mr. W. B. Turner's** communication on *Microthamnion vexator*, a new species of fresh-water algæ, was read, and a specimen exhibited.

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**Mr. Crisp** read a list of Fellows who had been nominated for election at the February Meeting as Officers and Council for the ensuing year.

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**Mr. P. J. Butler and Mr. R. Kemp** were duly elected Auditors of the Treasurer's accounts.

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**The following Instruments, Objects, &c., were exhibited:—**

Dr. Beale:—Slides illustrating his paper.

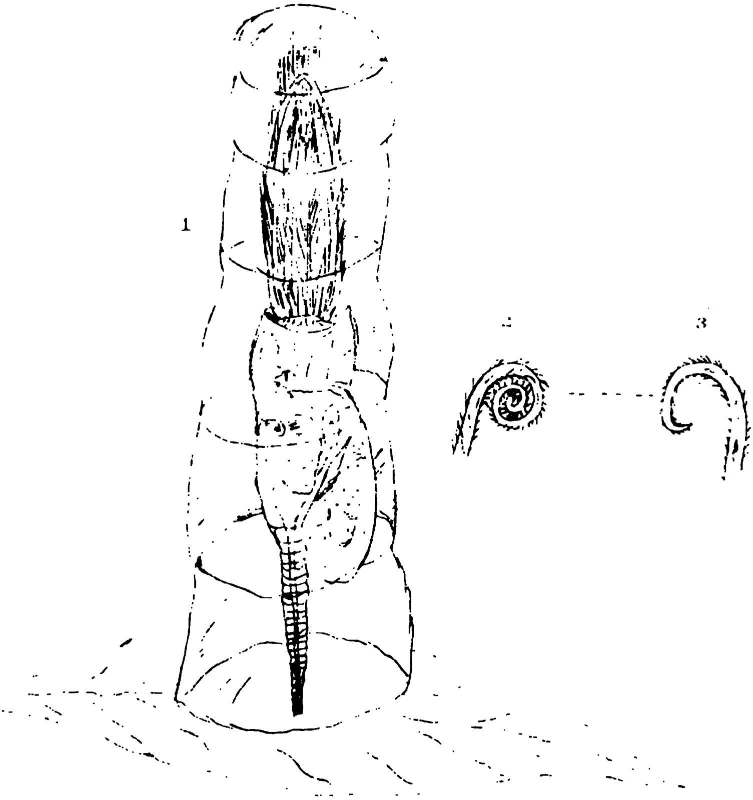
Mr. Crisp:—Bulloch's Objective Attachment.

Mr. J. Mayall, jun.:—(1) Parsons' Current Slide; (2) Nelson's Microscope Lamps.

Col. O'Hara:—Photo-micrographs of Blood-corpuscles.

Mr. W. B. Turner:—New Fresh-water Alga.

Dr. Van Heurck:—Diatoms mounted in styrax.



*Figs 1 – 3.* Stephanoceros Eichhornii.

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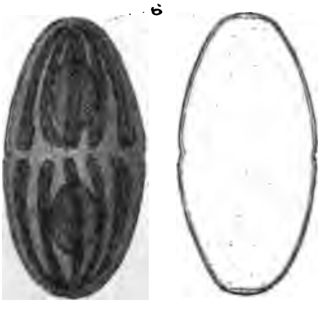

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# ROYAL MICROSCOPICAL SOCIETY.

APRIL 1884.

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## TRANSACTIONS OF THE SOCIETY.

### III.—*Observations on the Life-History of Stephanoceros Eichhornii.* By T. B. Rosseter, F.R.M.S.

(*Read* 8*th November* 1882, *and* 12*th March* 1884.)

Plate V. Figs. 1–3.

In the course of some observations to verify the fact that the cell of *Stephanoceros Eichhornii* is tubular, I determined to try the experiment of freeing the creature from its cell. I accordingly took a fine and healthy individual from my tank, placed it on the plate of the live-box with a small quantity of water, and after carefully observing it with a 1/2 in. objective and C eye-piece, I made an incision in the cell, and severed the creature's tail just above the sucker. After paring down the leaf to which it was attached, and substituting a 2-in. objective, I took a very fine lancet, and steadying the leaf with a needle and watching my opportunity, I severed the muscles, cutting the tail through close to the base, and I had the gratification of seeing it swim out of the cell, leaving the cell perfectly intact. I subsequently again tried the experiment, with the following results (extracted from my diary).

On Monday, May 15th (10 p.m.) I placed a good specimen of *Stephanoceros Eichhornii* in a moderately deep circular trough with a square base, my object for so doing in preference to using the live-box being to ascertain what amount of vitality existed after disconnection. This time, instead of merely making a small incision in the cell, I cut it straight across, completely dividing the cell, a small portion with the lower end of the tail being left attached to the piece of weed. The other, containing the animal and the greater portion of the cell, I dragged away into the middle of the trough, and awaited results. At first the creature did not attempt to move, its tentacles being completely closed up in the cell; but the mastax and the intestines kept moving. It remained in this state for two hours, and then began to rouse up, but instead of expanding the tentacles and making an exit out of the upper end of the cell as before, it began to *back* out of the cell by the lower end, and after some time cleared it, turned round, and gradually expanded the tentacles. I watched it a greater portion of the night, and it seemed in no way the worse for the operation it had undergone.

On Tuesday, 16th, 9 A.M., I found it alive and to all appearance anchored by the remaining portion of its foot, one cannot say sucker, because that had been left behind. At 10 P.M., twenty-four hours having elapsed, it was still alive, and seemed to be in the best of health in spite of the change in its circumstances. The tentacles were perfectly semicircular and rigid, which is a sure indication of health, they becoming limp and straggling when the creature is sickening or about to die.

On Wednesday, the 17th, at 7 A.M., I found the creature alive, and what is more strange, that it had thrown off an ovum in an advanced stage of development. The ovum was close to its side, but whether attached to it or not I do not know. Agitating the liquid in the trough as far as I dared did not disturb the ovum. By 11 A.M. the young *Stephanoceros* broke the shell and swam away, leaving the shell still clinging to the parent, where it remained until my observations came to a conclusion. At 11 P.M. (49 hours having passed) the creature was alive and well, and firmly fixed by its portion of tail, with algæ commencing to form at the base. At first I took this for the commencement of a new cell, but in this respect I was mistaken, for up to the time of its death it remained in the naked condition.

Throughout the day on Friday, the 19th, the creature was wonderfully active in finding and selecting food.

On Sunday, the 21st, all through the day there were unmistakable signs of approaching dissolution. The mastax worked in a very fitful manner. I left it in the evening, feeling sure it would be dead by the morning, as was the case, just eight days from the time of leaving the cell. I had great difficulty in finding the dead body and empty case, the growth of Oscillatorieæ, &c., having for the last day or two been so great that it was with the greatest difficulty the animal and the case could be kept from being hidden.

Another fact I think worthy of noting: Examining some *Anacharis*, I found an empty case of *Stephanoceros Eichhornii* containing an ovum left by the parent. I watched it, and saw the young one break the shell, come out into the cell, and after swimming round inside it, pass out of the aperture.

The above observations will speak for themselves, not only as to the character of the cell of *Stephanoceros Eichhornii*, but that it is able to live and propagate its species independently of the cell.

On another occasion I watched the development of a young *Stephanoceros* from the moment of hatching, and am able to verify the fact that the tentacles originate as buds, and unroll like the fronds of ferns. After the lapse of about eleven hours from the time of hatching, the upper portion of the young animal commenced to swell, and small buds began to be pushed upwards much in the same way as the tentacles begin to show themselves on the more advanced buds of *Hydra*. These buds were covered with minute cilia, and when they had been pushed up a short distance they began to gradually unfold (plate V. figs. 2 and 3) in the same manner as one sees the fronds of ferns unfold. They remained in this drooping state for two days, but on the third day took the beautiful arched form of the adult.

Ehrenberg was correct when he stated that *Stephanoceros Eichhornii* was viviparous, although at the time his ideas were considered erroneous. I have seen them give birth to young in this way very frequently, and on one occasion Dr. English * watched an individual under the same circumstances. The specimen that I watched was, when I found it, thoroughly sunk into the cell. The cell had not been retracted with the creature (fig. 1), but was perfectly erect. The creature was as I thought in a dying state, and nothing in the shape of food tempted it to come out of its cell. The posterior portion of the body was very much enlarged, and hung down like a bag. The tentacles seemed with the funnel to be thrust into the body of the creature; in fact, at times, it seemed huddled in a heap. After a short time it revived a little, and seemed inclined to elongate, but quickly retreated again. With a 1/2 in. and C eye-piece I saw the outlines of a young *Stephanoceros* in the pendulous portion, and later a slight opening in it through which it began to protrude head first. As it gradually came out, the posterior portion opened much wider, and the parent seemed to strain itself to get rid of its burden. At length it seemed about to do so, but the young one, as if fearful to trust itself from its mother, withdrew, but soon to be expelled by a violent effort on the part of the latter. After floating about in the cell for a short time, it made its escape in the usual way through the natural orifice. The mother never recovered, but died in the cell about half an hour afterwards.

The fact of the parent dying might at first sight seem to lead to the conclusion that this was not a true act of viviparousness, but I have, as I have said above, witnessed several similar cases, but not attended with the same fatal results to the parent.

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* Resident Medical Officer at St. Mary's College, Canterbury.

I may mention here the process which I adopt in examining *Stephanoceros.* I take an ordinary glass slip and place the object with a small quantity of water in the centre. I then shred some blotting-paper very thin, cut three small squares and place them at different intervals round the fluid, but taking care not to let the blotting-paper touch the fluid, or else the object will be drawn towards it by capillary attraction. I usually wet the blotting-paper, previous to putting it on the slip. I mention this as I have lost some valuable specimens through inadvertence. I then place the cover-glass over the object, letting it rest on the edges of the blotting-paper; and as the fluid evaporates it is easily renewed by wetting the edges of the paper. I find twice in twenty-four hours quite sufficient. The process is very simple and inexpensive, and I have found it answer better than the usual live-box or compressorium. I have kept *Stephanoceros* alive thus for ten and twelve days, and have watched its progress from the ovum to maturity. What is important to any one whose means are limited, it is inexpensive, and very convenient. I keep it covered, when not under observation, with a small watch-glass.

## IV.—*The President's Address.*

By Prof. P. Martin Duncan, F.R.S., V.P.L.S., &c.

(*Annual Meeting*, 13*th February*, 1884.)

The two addresses which I have had the honour of delivering as your President, were mainly devoted to the consideration of the practical optics of objectives of high power. On the present occasion I desire to direct attention, amongst other matters, to the importance of the perfection and use of those combinations of lenses which do not amplify greatly, and yet are more frequently employed than high powers and quite as usefully.

The combinations which give large amplification, are doubtless very attractive to the high-class microscopist, who prides himself on overcoming the difficulties attending the employment of his objectives, and they are of course absolutely requisite in most microscopical investigations. But the low powers—so readily and easily managed, so necessary before the employment of the high-power objective is attempted, so important in the use of the binocular Microscope and of the polarizing apparatus, and such auxiliaries to the hand-lens, from the readiness with which opaque objects can be viewed—are of paramount importance to microscopists of every degree.

There are many microscopists who enjoy the use of their instruments without any desire or power to add to the original research which accumulates so seriously year by year. They like to see beautiful things, to marvel at the æsthetics of nature, to examine the intricacies and delicacies and exquisite symmetry of the structures of natural objects which so far surpass the results of the art and industry of man. To all these followers of our science the low-power objective is of primary importance. Many hundred lithographic plates are published, year by year, on which are depicted minute recent and fossil forms which could not be studied without the low-power objective, and which do not come within the scope of high amplification. As being necessary to the most advanced investigators of minute things in their preliminary work, as absolutely necessary for the draughtsman and describer of opaque and transparent small objects, and as the media of great intellectual enjoyment, the objectives which are termed low in power, from their magnifying capacity being small, and which have from 1/2 in. to 4 in. of focus, should always receive attention. They illustrate the supreme ease with which former weary labour has been superseded.

A good monocular or binocular stand, a large and movable stage with its proper accessories, and the bull's-eye, mirror, and illumination to match, are almost invariable accompaniments of the low power. The observer can work hour after hour and with but little fatigue. The object can be drawn with or without the camera lucida; and if it is a rock specimen the polariscope can be used with ease.

It was quite another matter in days gone by, when, however, most lasting—indeed everlasting—work was done with the aid of the low and imperfect powers. Compare the luxurious microscopist of to-day with the painfully labouring yet ever illustrious Swammerdam. In working at his memoir on the Day-fly, the figures in which are marvels of exactitude, Swammerdam excited the admiration and pity of Boerhaave, who wrote of him as follows: "All day he was employed in examining objects, and at night described and delineated what he had seen by day. At six in the morning in summer, he began to receive sufficient light from the sun to enable him to trace the objects of his examination. He continued dissecting until 12 o'clock, with his hat removed, lest it should impede the light, and in the full glow of the sun, the heat of which caused his head to be constantly covered with profuse perspiration. His eyes being constantly exposed to a strong light, the effect of which was increased by the Microscope, they were so affected by it that after midday he could no longer trace the minute bodies which he examined, although he had then as bright a light as in the forenoon."

But it was long after the time of Swammerdam before comfort and microscopical investigation were associated. Even after the achromatic system had been discovered and utilized, the "doublet" and "triplet" were used; but these scientific atrocities gave way to the combination of lenses now employed, and the days of comparatively easy working began. Great care was taken in the manufacture of the objectives of low power in this country, and magnificent specimens of science and art were speedily brought forth. I speak under correction, but it appears to me that there has not been any great improvement upon the low-power objectives which were produced by our great Microscope-makers a quarter of a century since. There has been an influx of second-rate low-power objectives, together with those of a high class, and the reason has been, not from any deterioration in the skill of the artizan, but from the belief, on the part of the public, that low-power objectives are more easily made than those of high power, and that therefore they should not be so costly. This is a great mistake, and the mischief produced by it, in the demand for cheap low-powers, has not been checked by the experience of those microscopists who almost entirely use objectives of a high amplification. Many investigators rarely employ a low power, and provided their high power objectives are good, they are satisfied with something that will act as a low magnifying power. It does not require much experience to prove the great differences between the qualities of low powers of the same supposed amplification. A good low-power objective requires more work to be done on it than does a high-power combination, and hence the similarity in cost of a first-rate English low power and a foreign high power. This special work is not always given, and hence the diversity of merit in the lowest powers obtained from different quarters. The absolutely requisite qualities of first-class low-power objectives are a large flat field, achromatism, definition, a good penetrating power, accurate centering and as little spherical aberration as is possible. Of the vast number of cheap lenses now produced, it can only be said that it is to be regretted that the public will not consider that they cannot be made good for the money they cost.

There are very considerable differences in objectives of 1/2 in. focus, but it is really a good plan to have one of a considerable aperture and another for ordinary work, with a less aperture and greater penetrating power. Those of the last-mentioned kind are the most valuable with the binocular, after having their brasswork shortened. These lenses and, indeed, all the low powers which are so readily used with the binocular, are often severely tried by it, and their errors become very prominent. Moreover, the indifferent prismatic arrangement of many binoculars is exposed by the objective.

The lowest powers compete with the hand-lenses, and these are rapidly increasing in excellence. It is remarkable how necessary it is to employ the simple hand-lens after or before submitting small, irregularly shaped, opaque objects, like corals and foraminifera, to the compound Microscope for purposes of illustration.

Most artists acknowledge that the details of the object are beautifully rendered by the objective and Microscope, but that they only get a true and general idea of it by using the hand-lens. Particular direction of the light, the depth of shadow, and the exaggeration of the details of one part over those of another, characterize the performance of the Microscope armed with a low-power objective; and a diffused light, less contrasting shadow, and a more symmetrical and general amplification are the gifts of the hand-lens. The Microscope employed with a low-power objective is further removed than the single lens from the eye, as an instrument. These differences are amongst the proofs of the distinction between ordinary and microscopic vision.

The utility of low powers and their easy manipulation have been greatly increased by numerous appliances, most of which have been carefully considered by this Society. The different kinds of reflectors and condensers of light, and the methods of dark-ground illumination with oblique rays of light, are amongst the most important. The alteration of the binocular system to suit a more or less horizontal position of the tube and to correct reversal of the image, has produced an instrument which gives the greatest facilities to workers, and under which dissection and selection can take place very readily. It supersedes the old plan of placing a low-power objective on the draw-tube when using a low objective, although this is an excellent plan.

The improvements in the camera lucida are all in favour of the low powers, and certainly during the past year this important adjunct has been presented in many forms to the Society. One apparently diminishes the almost inevitable distortion of the reflected image, and another gives a great field with a very visible end to the operator's pencil.

The improvements in the manufacture of the polarizing apparatus and the admirable substage movements, which have so frequently been exhibited before the Society, raise the value of the low powers in the important and most necessary study of rocks. Finally, the ready change of objective by such methods as that of Dr. Matthews, is gradually doing away with the nose-piece, an adjunct to the Microscope which, if well made, is very useful, but which if badly made is especially pernicious to the development of the good performance of the low-power objective.

Some important communications have been read before the Society on the theory of the Microscope, and it is satisfactory to acknowledge their great practical bearings. I allude especially to the papers of Prof. Abbe and our Secretary, Mr. Frank Crisp.

Prof. Abbe's communications are full of interest. One relates to the measurement of the refractive index and dispersive power of fluids, without having resort to the old cumbrous methods [by hollow prisms. Abbe's refractometer is said to fulfil all that is required of it. The leading principle of the apparatus depends upon the obstruction of the rays by total reflection at the surface of the fluid under examination.

Wollaston and others adopted the method of observing the maximum intensity of the reflected ray; but a great advantage is gained by observing instead, the maximum intensity, so to say, of the transmitted ray. In the former case there is a difficulty in ascertaining the precise point where the light reaches its maximum, whilst in the latter a very small amount of light is easily detected in the darkened field. A second communication is a continuation of one on the Rational Balance of Aperture and Power, and relates to the division of the entire power of the Microscope between ocular and objective. The necessity for this balance was urged in my last Presidential Address.

Our Secretary's paper relates to the measurement of the magnifying power of the complete instrument with eye-piece, tube, and objective, and exposes the fallacious empirical methods hitherto employed, and showing that the correct amplification can be determined by the use of a very simple formula.

The last year has shown that there has been more activity amongst the Fellows of the Society in original researches and in the practical employment of the Microscope.

Mr. Michael has continued his most interesting and valuable work on the Oribatidæ, and now science has the advantage of much correct knowledge regarding the anatomy of this interesting group.

Dr. Hudson, pursuing his admirable researches amongst the Rotifera, has added three new and very remarkable species of the exquisite genus *Floscularia* to natural history. Most of us recollect the first *Floscularise* that we ever saw: how out of a dull looking indefinite lump a projection appeared, and how long, slender, apparently never ending, threads grew on; how these slender threads radiated from certain spots and seemed as rigid as bristles; and how this most delicate creature possessed rotifer-like jaws, and how the whole gradually retracted, and as it were turned itself in. Some of Dr. Hudson's new forms depart, however, considerably from the common type of *Floscularia*. His *Floscularia hoodii* (*hoodii* by name, *cucullatus* by nature!) is the largest of all the rotifers, has only three lobes and possesses two remarkable flexible processes placed one on each side of the summit of the dorsal lobe. These have been carefully studied by Dr. Hudson, because their antenna-like appearance is striking. He did not find the slightest trace of setæ in connection with these processes. They appear to be hollow, and to communicate with two sub-spherical spaces lying between the two surfaces of the dorsal lobe. Fine muscular threads pass down and across them, and the animal can contract and expand each independently of the other and throw them into all kinds of positions. The upper end of each seems to be separated partly from the remainder by a constriction, from which a muscular thread runs down to the base. These movable processes do not both project invariably when protrusion of the animal occurs from its case, and they appear to discharge a granular matter. There is a point of interest also in the long filamentous setæ. Dr. Hudson states that, the thickened rim of the three lobes carries a double fringe of setæ, set just as they are in *F. trifolium*, the larger row stretching outwards and the smaller inwards; and he has on several occasions seen a rapid flicker run all along the smaller setæ, not constant or regular enough to produce the phenomena of "rotation," but still a very obvious motion of each separate seta. The gape of the mouth-funnel of this rotifer alters constantly and closes by means of its many muscular threads. It has two pale pink eyes and the contractile vesicle is large and plain and contains a cluster of yellow globules.

It is to be hoped that Dr. Hudson will continue to investigate this most remarkable form. Another species discovered and described by Dr. Hudson is *Floscularia ambigua* which, he says, is the least elegant of all the species, being broad and stumpy and trilobed. It is, however, allied to *F. hoodii* in some points, and its curious habits compensate for its inelegance. Mr. Hood writes: "This Floscule is not a beauty, but what it wants in grace it gains in interest, for it is most amusing to watch it feeding. As soon as it has fully expanded its large head, infusoria of various species may be observed to be drawn swiftly down the large cavity formed by the lobes. The inward-setting current, thus formed by the cilia at the base of the cavity, seems to be stronger in this species than in the others, for large animalcules, such as *Kolpoda* and *Paramecium*, and even free-swimming rotifers will often fall victims to this big, burly and voracious creature. It has an insatiable appetite; I have frequently seen the young of *Œcistes pilula* and *Œcistes umbella* devoured by it, the young of the large rotifers making even less resistance than the infusoria. It is not purely carnivorous, for the young of *Volvox globator* fall a prey. Whenever it has got a victim within its great mouth-funnel, there is no possibility of its making its escape; although, with a full stomach, *F. ambigua* seems inclined to play with its prey as a cat would with a mouse, allowing it to swim about within the funnel, and to try and escape over the margin. Whenever the animalcule approaches the setigerous rim, a sharp stroke from one or more setæ drives it back into the funnel. I have seen the attempt to escape made over and over again, but always with the same result; in no single instance have I ever witnessed the escape of a captive. No one could credit the voracity of this Floscule who had not watched it. I have seen one eat in half an hour no less than twenty-four live infusoria of various sizes with a young Rotifer and Volvox now and then."

Dr. Hudson notices that the males of *F. ambigua* are hatched from smaller and rounder eggs than the females. Their digestive organs and mastax are wanting; the anterior portion of the body was transparent, bearing a wreath of long vibratile cilia and two red eye-spots. Dr. Hudson bears testimony to the variation in the number of the setigerous lobes of the Floscules, and after noticing that three and five are common numbers, and that five and six in the same animal is a somewhat doubtful fact, determines that a new form, *F. regalis*, has seven lobes, which are knobs on festoons, and are crowded with setæ.

Dr. Hudson has also communicated a very interesting paper on the Humped Rotifer, *Asplanchna Ebbesbornii*, and has not only treated his subject zoologically, but also morphologically. Of the male of this species, Dr. Hudson states, the whole range of the Rotifera does not contain a more curious or more beautifully transparent creature; it may be 1/30 in. long, and is a slow swimmer; yet it is so transparent that it is almost invisible to the naked eye. Under the Microscope it looks like a many-pointed bubble of glass. This male has no digestive organs, and nature in compensation has given him some stored material for his nutrition. Dr. Hudson gives drawings of the tortuous threads and tags that are so constantly present in Rotifers. He delineates the spermatozoa and the central portion of the ovary of the female with maturing germs.

Our Secretary, Professor Bell, has given us some accurate figures and descriptions of the spicules of the body-wall and suckers of the Holothurians named *Cucumaria hyndmanni* and *C. calcigera*, and in concluding his essay he remarked that the greatest care is required to preserve the parts of typical specimens if they are to continue to be of value. The spicules of one of these species, *C. calcigera*, were carefully studied by my colleague, Dr. Percy Sladen, and published in our work on the Arctic Echinodermata. On examining our figures, plate I. figs. 6, 7, and comparing them with those of Professor Bell, it would appear that there must be alterations proceeding in the spicules during the preservation of the specimens. Possibly the methods employed to exhibit the specimens may modify them. The microscopic details in our figure of a small spicule in profile (fig. 7) are more ample than those in our Journal (vol. iii., plate VIII., fig. 2*a*) and it would appear from our figure (6) of spicules from the superficial layer *in situ*, that there must be variation in those structures in different individuals.

Mr. Conrad Beck has described some very interesting Cladocera from the English Lakes in our Journal, and his figures of them are most praiseworthy. It is to be hoped that this is by no means the last of his communications. He has chosen a subject full of interest to the naturalist as well as to the investigator of the great movements of the crust of the earth. The relation which some of these Cladocera bear to marine forms is obvious, and Lovén, Agassiz, and myself have pointed out their occurrence in positions which indicate their entry before the country assumed its present physical aspect. Their occurrence in the Swiss and Norwegian lakes is very antagonistic to the idea of the excavation of these areas by ice.

The Diatomaceæ have been the subject of some very interesting researches. Methods of making fine sections of these delicate silicious bodies have been suggested and carried out with some success. It could hardly be expected that a year could pass without some further researches on the cause of the movement of the diatom when free. The mechanism has not yet been publicly demonstrated, however, although some few microscopists have had the good fortune, under very exceptional circumstances, to see (or fancy they saw) external protoplasmic movements. The communications on this subject to the different scientific journals are, as is usual when the subject is in the non-verifiable stage, very dogmatic and contradictory. Still the homogeneous-immersion lens of high power should be the means of determining the cause or causes of the movement.

Our Journal has been made more valuable during this year by the publication of the very careful and intelligent researches of Messrs. Morris and Henderson on *Trichophyton tonsurans*. They describe the life-history of the fungus from the sowing of the spore to the branching of the resulting filaments on the sixth to eighth day. Moreover they describe the aerial hyphæ and fructification. Remarking on the difficulties of determining the botanical position of the ringworm fungus, on account of the frequent development of adventitious fungi, Messrs. Morris and Henderson endeavoured to obtain a medium which should possess perfect sterilization and should have sufficient consistence to retain spores in a fixed position for continuous observation. They came to the following conclusions, illustrating their paper by photo-micrographs (employing a 1/5 in. object-glass of Beck and an amplification of 1000):—That the spores of *Trichophyton tonsurans* grow freely on the surface and in the substance of gelatine peptone at from 15° and 25° C. That the mycelium only will grow in the substance of the jelly, and that the hyphæ require air to produce conidia. That the branching, septa-formation, and fructification are identical with those of *Penicillium*. That the spores of the second generation reproduce ringworm on the human skin. That outgrowths resembling resting spores appear on some of the filaments.

The red mould of barley has been most carefully examined and illustrated by Mr. C. G. Matthews, F.C.S., and published in one of the parts of the Journal. The common coloured mould seen at the germinal end of the corn was grown on a large scale by breaking up germinating barley with a little water into paste. Very fine silky tufts of the red mould were thus obtained from 1/2 to 3/4 in. in length and nearly 2 in. in diameter. Much of the red colouring matter was diffused amongst the plasma and the hyphæ were tinged with it, where they sprang from the nutrient surfaces, though their extremities were colourless. The hyphæ gradually became interlaced and flattened down as a mass and a kind of sporulation began to be noticed, and pseudo-spores—very minute bodies—came from the threads. They did not appear to develope. Shortly after the flattening of the hyphæ, a pink dust was seen here and there on its whitish surface. This consisted of clusters of crescent-shaped spores. They appear to sprout from the extremities of short hyphæ. From these crescent-shaped bodies, which are spores, fresh growths of the mould could be obtained by sowing on a suitable surface. The red colour is the matter surrounding the crescent-shaped spores. The mould holds its own against other kinds, and sooner or later swellings occur in the threads of the hyphæ and on sporangia. The contents discharge with the application of water, and the spherical spores were sown, and they reproduced the red mould. The author described a similar mould on the melon.

I speculated in my last address regarding the future of research into the life-history of bacilli, and the results of the work on this subject during the past year have been really most wonderful. Dr. Ransom condensed the breath of phthisical patients and obtained bacilli, rendering them visible by what may be called the Gibbes process. He found that they were indistinguishable from those found in the sputa and in tubercle. It is not reassuring to know that bacteria exist in vast multitudes in the soil, but M. Miquel has shown that at Montsouris an average of 750,000, in the Rue de Rennes 1,300,000, in the Rue Monge 2,100,000 germs exist per gramme. Brautlecht mixed baked sand, gritty earth, and tolerably loamy garden mould with liquid containing bacteria, and covered the mixture with a bell-glass. A few hours after, there were a great number of micro-organisms in the vapour condensed under the bell-glass, and of the form of those contained in the liquid. The sprinkling of dry sand over the earth diminished the number of organisms. It is comforting to read that while rain is falling, the number of the bacteria in the air is sensibly diminished; it increases, however, when the ground dries, and diminishes with ten to fifteen days' drought. Miquel states that at Montsouris, the average number of bacterial germs per cubic metre of air is 142 in autumn, 49 in winter, 85 in spring, and 105 in summer. The same author states that the number of germs in hospitals is vast, amounting in the summer months to an average of 5600, and in the autumn to considerably over 10,000 per cubic metre of air.

The sensitiveness to light of *Bacterium photometricum* is accompanied by more remarkable properties, for these organisms accumulate in media in positions where the invisible ultra red rays of the spectrum penetrate. The influence of light on the development of bacteria has been shown in the instance of *Bacterium termo* to be remarkable. Direct sunlight kills bacteria, diffused sunlight does not; but this statement has to be qualified, for Jamieson discovered that temperature has to do with the matter, and that at moderate and low temperatures direct sunlight does no harm to the organisms. Direct sunlight and air, by drying up bacteria, destroy them. Some bacilli, those of anthrax for instance, which exist in serous matter from anthrax tumours, may be dried at a temperature of 32° C. = 89°·6 F., and then exposed to 100° C. = 212° F. It is stated that not only do the organisms resist heat, but become able to resist antiseptic agents. They do not, however, appear to act as definitely as before, but they produce modified anthrax. Following on these results, those of M. Chauveau are very interesting. He mixed a sterilized infusion of meat with the blood of cattle disease, and placed the mixture first in a temperature of 42–43° C., and then to 47° C. It appeared subsequently that although the vital activity of the bacillus was not interfered with, its capacity for acting as a disease-producer was destroyed.

One of the most suggestive observations on bacteria has been that which indicates that they act as starch and diastase in the absence of other carbon nutriment, and that the action on starch is effected by a ferment secreted by them, and which like diastase is soluble in water, but precipitable by alcohol. This ferment acts as diastase, changing the starch into a sugar capable of reducing cupric oxide, but not possessed of peptonizing properties. It is to be hoped that after all this searching after bacteria and after these recondite experiments have been conducted over again, that some definite study of the bacteria of a locality where such diseases as ague prevail will be undertaken. The whole history of the disease points to a bacterian origin, and there should be no difficulty in examining the secretions with a view of thoroughly investigating the organism.

A paper lately read before the Royal Society proves that solution of quinine is fatal to certain bacteria, even to those of phthisis, and the well-known influence of that drug over ague should stimulate therapeutists to investigation.

There have been two communications to the Society on special methods of preserving delicate organisms for the use of the Microscope, which are of exceptional interest and value. Mr. Lovett has explained his intelligent method of using what he properly calls a judicious admixture of various proportions of alcohol, glycerine, and water to Haentsche's fluid, which consists of alcohol absolute 3 parts, pure glycerine 2 parts, and 1 part distilled water. *Limnocodium Sowerbii,* the wonderful medusoid which, living in fresh water at 85° Fahr., is such a marvel so far as its origin is concerned, has become preservable, thanks to Mr. Squire's weak solution of bichloride of mercury. There is no doubt that this medium will be further employed. Mr. Saville Kent has suggested the use of weak solutions of potassic iodide for preserving infusoria, and Mr. Waddington has contributed a paper on the use of tannin in showing infusoria.

It is a matter of great congratulation that the Society maintains its character at home and abroad as a useful and truly scientific institution. There is no doubt that great progress has been made in microscopical science during the last few years and that the communications read before this Society, the recorded debates and their influence on our large and increasingly important number of Fellows have assisted in this satisfactory state of things. The Society may take the credit of having now completely eradicated the old and very erroneous notions regarding what was called "angular aperture," and of having disseminated and established the knowledge of aperture in its correct signification and the use of the "numerical aperture" notation. The first term has, indeed, almost ceased to be employed by advanced microscopists. The homogeneous-immersion principle has been developed and the media which have been proved to be so valuable have originated with Fellows of the Society and have been recorded in the Journal.

I feel a sensation of some pride that I should be able to hand over the presidency of this Society in the midst of its useful and prosperous career to an observer of the highest class of excellence, whose success has been assured by the employment of the instrument which has been largely perfected by the intellectual and mechanical gifts of Fellows of this Society. I may, I trust, (without the least desire to stop the particular physical and mathematical tendencies of many of our Fellows) urge the great number of good observers of nature amongst us to be stimulated by the very valuable reports of the researches on the structures of the invertebrata and plantæ, which appear in the Journal—a compendium of which the Society may justly be proud—to undertake work which may come before their future President and receive his criticism. In fact it may be hoped that that excellent Journal will contain more records of the labours of the Fellows of the Society.

In the proceedings of all great Societies there are occasions when congratulations and the desire for future usefulness have to give place to very opposite expressions. Men toil and pass away, and others enter into their labours.

The present occasion is no exception to the rule. We have to deplore the loss of three great practical opticians, two of them being microscopists of the highest renown. One had attained an age far beyond that which is usually noticed amongst men who have laboured with head and hand, and on looking back at his life it must be admitted that by his means an immense amount of intellectual pleasure was given to the world, and a great amount of exact knowledge has been consolidated.

For fifty years the name of Powell has been a household word amongst microscopists, and now it remains only to the sons of the late Mr. Hugh Powell. The distinguished man whose name I have just mentioned was amongst the first of the Fellows of this Society, and long before the year 1840, he had become celebrated for his microscope-stands and lenses. His name will always be remembered as that of a designer and maker of first-class high-power objectives, and as a conscientious maker of the ordinary powers. The following obituary notice has been already published, and it expresses the merits of Mr. Powell :—

"In 1834 he was awarded a silver medal by the Society of Arts 'for a stage for a Microscope.' In 1840 he succeeded in making an achromatic object-glass of 1/16 in. focal length, which the late Professor Quekett, in his treatise on the Microscope, stated was 'the first that had been seen in this country'; and in 1841 the Society of Arts awarded him a silver medal 'for his mode of mounting the body of a Microscope.' Mr. Powell was the first optician in England to construct object-glasses on Amici's 'immersion' system. A 1/25 in. was made by Mr. Powell in 1860, a 1/50 in. was perfected in 1864, and a 1/80 in. in 1872. The more recently developed formula of the 'homogeneous immersion' system was the subject of special attention on the part of Mr. Powell and his brother-in-law and partner, Mr. Lealand, but failing health compelled him to rely upon the efforts of his son, by whom object-glasses on this formula having the highest apertures on record have been constructed. Mr. Powell was among the earliest on the roll of Fellows of the Society at its foundation in 1840."

Microscopical science has also to deplore the death of a very able and most distinguished practical optician in the United States. Mr. Robert B. Tolles has left a name in America and Europe which will always be mentioned with respect. He was a skilled objective-maker of the first class, and like most men of his mental and artistic calibre was a quiet and unassuming gentleman. Tolles was always ready to avail himself of discoveries and seized at once upon the value of the lenses with large numerical apertures, and he also speedily availed himself of the improvements of the homogeneous-immersion principle. He was not, as one of his friendly biographers states, entitled to the credit of showing the practicability of this system. It was Amici, Stephenson, and Abbe, as I stated in my first Presidential Address, who established the homogeneous-immersion system. Tolles, however, developed the apertures of high-power objectives and produced admirable results, being the first to manufacture combinations of lenses of high amplification and suited to the immersion system in America.

The last obituary notice relates to Henry Dallmeyer, who was so well known in the sister sciences of astronomical and photographic optics. Mr. Dallmeyer left Germany in 1849 and came to England, entering the house of the late Andrew Ross, the founder of the well-known optician's business bearing his name. Mr. Dallmeyer's attention was at first devoted principally to the construction of astronomical telescopes, for which, in conjunction with Mr. Ross, he computed a large number of formulæ. At his death, Mr. Ross bequeathed to Mr. Dallmeyer the bulk of his optical appliances for the manufacture of telescopes. About this date (1855) photography began to be popularized by the general adoption of the collodion process. Mr. Dallmeyer quickly discovered that the photographic lenses then in use stood in great need of improvement in every direction. In rapid succession he produced lenses for landscape and portrait photography, and it is greatly owing to his efforts that English lenses now rank second to none. He was specially commissioned to provide several of the telescopes and photographic appliances used by the different Government expeditions for the observation of the recent transit of Venus, and his telescope object-glasses are in high repute among the leading astronomers. Mr. Dallmeyer died at the age of 53.

One more duty falls upon me, and it is a very pleasurable one. I have to thank the Fellows of the Society for the consideration they have shown me during my three years of office, and for the manner in which they have borne with my shortcomings. In taking leave of you as your retiring President I do most sincerely congratulate you on the accession of Mr. Dallinger to the presidential chair, a position for which his great scientific reputation so thoroughly recommends him.

## V.—*On the Mineral Cyprusite.*

### By Julien Deby, C.E., F.R.M.S.

(*Read* 14*th November*, 1883.)

In November 1881, Dr. Paul Reinsch, through Professor Stokes, communicated to the Royal Society a note on a mineral to which he gave the name of *Cyprusite*, of which he had brought back to Erlangen a small specimen on his return from Cyprus.

Having myself had the opportunity of visiting the same region of country during the present summer, I took advantage of it to collect numerous specimens of this substance, from many different localities.

Believing that further observations relating to this cyprusite may prove of interest to petrological microscopists and others, I have drawn up a short note summing up the further history of this curious natural product, the result of my own investigations.

The cyprusite is found in the shape of rocks, forming several bold superficial parallel outcrops of rather irregular longitudinal outline, running in a direction north-west to south-east in the district of Chrysophou, in the north-west portion of the island of Cyprus, and mostly distributed over the mountainous territory comprised between the villages of Poli, Lisso, and Kynussa. These outcrops extend in some cases several hundred yards in length, with a width oscillating irregularly between 30 to 100 yards. Their colour varies from a pale dirty yellow to a bright cinnabar red, with all intermediate tints.

The texture of the rock varies from a quite soft friable consistency, falling to dust between the fingers, to a quite hard and compact rock. The former or softer variety is the most abundant.

A careful geological examination shows that the cyprusite is imbedded in plutonic rocks, melaphyres, and wakes, containing occasionally zeolites, it occupying wide crevices in these eruptive rocks, which latter have forced their way in vast masses through the stratified tertiary fossiliferous limestones of the country.

The present height above the sea of the cyprusite deposits varies from 350 to 1200 feet, the distance of the same to the north coast of the island in a straight line varying from three to six miles. The principal deposits are situated on the right bank of the Ballahusa river, and below the village of Kynussa.

Having noticed that wherever cyprusite outcrops were to be seen traces of ancient mining and heaps of old slags were also to be discovered in the vicinity, and that the old workings penetrated in many places into the hill-sides below the yellow masses, I came to the conclusion that the cyprusite knobs and bluffs formed the outcrop ("gossan," as Cornish miners would call it) of the copper lodes so celebrated in the times of remote antiquity. A further investigation has led me to the belief that, at a certain depth, the cyprusite is replaced by iron pyrites, and that lower down still these pyrites become cupreous, and that these constituted a portion of the mineral which was worked by the Phœnicians, Greeks, and Romans in the island of Cyprus.

I observed in several places below the cyprusite the efflorescences mentioned by Dr. Reinsch; their composition is as follows:—

| | | |
|---|---|---|
| Insoluble in water .. .. .. .. .. | 4·88 | per cent. |
| Copper .. .. .. .. .. .. .. | 0·45 | „ |
| Iron .. .. .. .. .. .. .. .. | none | |
| Alumina .. .. .. .. .. .. .. | 17·70 | „ |
| Sulphuric Acid .. .. .. .. .. .. | 35·19 | „ |
| Water of crystallization .. .. .. .. | 39·00 | „ |
| Total .. .. | 97·22 | „ |

This mineral had a whitish, slightly greenish tinge and semi-crystalline structure, and looked exactly like weathered sulphate of iron. It consists, however, essentially of sulphate of alumina (nearly $2\,Al_2O_3 . 5\,SO_3 + 25\,H_2O$) coloured by copper.

The cyprusite was submitted for complete analysis to my friend Henry Fulton, Esq., the late well-known and able chemist to the Rio Tinto Company, now of Aguilas, Spain, to whose kindness I am indebted for the greater part of the chemical determinations in the present communication.

A first experiment consisted in simply drying the mineral to from 100 to 115 degrees Centigrade, when slight vapours which coloured litmus blue were given off. Another portion was next submitted to a red heat in a platinum crucible for six hours, until the fumes ceased to colour litmus paper, when it was found by analysis that 17·19 per cent. of sulphuric acid had been given off. At the same time the colour had passed from yellow through bright red to a dark purple.

The *average* of several carefully made analyses of the yellow or typical and most abundant variety of cyprusite, after separation of the insoluble portion, which, as we shall see, does not enter into the chemical composition of the mineral, was found to be:—

| | | |
|---|---|---|
| Ferric oxide, $Fe_2O_3$ .. .. .. .. .. | 49·68 | per cent. |
| Alumina, $Al_2O_3$ .. .. .. .. .. | 3·89 | „ |
| Sulphuric acid, $SO_3$ .. .. .. .. .. | 35·34 | „ |
| Water, $H_2O$ .. .. .. .. .. .. | 11·06 | „ |
| Total .. .. | 99·97 | „ |

The mineral is thus seen to constitute a normal sulphate of alumina with anhydrous ferric tribasic sulphate, the whole having the formula, $Al_2O_3 . 3 SO_3 + 18 H_2O + 8 (Fe_2O_3 . SO_3)$, the theoretical composition of which would be as follows:—

| | | |
|---|---|---|
| Ferric oxide, $Fe_2O_3$ .. .. .. .. .. | 49·47 | per cent. |
| Alumina, $Al_2O_3$ .. .. .. .. .. | 3·98 | „ |
| Sulphuric acid, $SO_3$ .. .. .. .. .. | 34·00 | „ |
| Water, $H_2O$ .. .. .. .. .. .. | 12·52 | „ |
| Total .. .. | 99·97 | „ |

differing from the result of Dr. Reinsch's essay, as published by him in the 'Proceedings of the Royal Society' for 1881, No. 217.

The most interesting facts connected with the cyprusite are, however, revealed by a careful microscopic examination of the mineral. It is then found to consist of a loose to compact aggregate of very minute, translucent, very slightly coloured crystals, the microscopic "projection" of which is generally more or less regularly hexagonal. These crystals vary in diameter from 1/120 to 1/300 of a millimetre = 8·30 $\mu$ to 3·32 $\mu$ = 0·00032 of an inch to 0·00013 of an inch. These are entirely soluble in hydrochloric acid, but insoluble in water.

Calcining converts these crystals into an opaque substance, which generally retains the previous outline.

Crystals are frequently found irregularly formed, as also occasionally compound or twin-crystals. Under the polariscope the micro-crystals, if examined dry or immersed in water, would, by a superficial examination, be taken for isometric, an appearance which is due to the hexagonal disks, all presenting this same face towards the optical axis of the instrument, but if mounted in thick balsam so as to lie in various positions to the observer, they are found, small as they are, to be beautifully anisotropic, the hexagonal sections alone remaining obscure under the crossed Nicols, so that the crystalline system may be safely laid down as rhombohedral or hexagonal. This determination is further supported by the fact that some of the larger crystals seem to present apical modifications which are multiples of three.

It will be remembered that the ordinary alums, as also copperas, crystallize in the monometric system, so that cyprusite seems to constitute a really good and distinct mineral species.

I may add that cyprusite is insoluble in water, and that analysis has failed to detect in it either lime or magnesia. The specific gravity is 1·8. Completely immersed in this bed of minute crystals of cyprusite are to be found scattered numerous *silicious* organic remains (non-polarizing) to the extent, on an *average*, of about 16·90 per cent. of the whole bulk, along with a very few small grains of quartz sand, which last are readily distinguishable under the micro-polariscope.

The Microscope shows that these silicious organic remains, invisible to the naked eye, consist of the skeletons of marine polycistins (Radiolaria) in a tolerable state of preservation, along with many smaller débris of the same, as also of a few sponge spicules, but I could discover no diatoms among them.

The cyprusite polycistins belong principally to the group comprising the *Heliosphæridæ*, but a curious elongate conical form of a *Polycyrtida* is not uncommon in the deposit as well as representatives of some other families. The insoluble residue of the mineral after treatment by acids consists almost entirely of these organic remains. Ehrenberg's and Haeckel's works not being at my disposal at my present residence in Spain, I cannot determine the species nor even the genera of these Radiolaria, nor can I establish if these forms are still living in the present surrounding seas. I must, in consequence, leave this work for others better situated, and to whom I will be glad to communicate the necessary material on application.

One thing is certain, namely, that at one time or another, the cyprusite beds must have existed under the level of the sea.

The origin of the cyprusite is a subject of some difficulty, and lies, to a certain extent, within the realms of scientific speculation. Its chemical production, as well as its geological genesis, may, however, I believe, be explained theoretically by reference to the following considerations:—

It is well known that a solution of a ferrous sulphate, exposed to the air, undergoes oxidation. According to F. Muck,* in the earlier stages of the oxidation, the solution contains normal ferric sulphate $Fe_2O_3 . 3\,SO_3$, and even free sulphuric acid, but ultimately the basic salt $Fe_2O_3 . 2\,SO_3$ distinguished by its deep brown colour. At the same time the deposit becomes progressively richer in acid, without, however, attaining the composition $2\,Fe_2O_3 . 3\,SO_3$ assigned to it by Wittstein.†

The products of the oxidation vary with the continually changing composition of the solution, and cannot therefore be reduced to any simple expression. As a rule, ferric sulphates, occurring as natural products, are partly precipitates of this kind, and partly dried up mother-liquors.

The *tribasic ferric sulphate* $Fe_2O_3 . SO_3 = Fe_2(SO_4)_3\,2\,Fe_2O_3$ is produced artificially as a reddish yellow powder, containing about 3 at. water, by dissolving the basic double salts of potassic sulphate and sesquibasic ferric sulphate in water, and heating the solution (Soubeiran).

If potash or soda be added to a concentrated solution of ferric sulphate till the precipitate no longer redissolves, the filtered solution yields by spontaneous evaporation olive green or *yellow six-sided tables* of the basic salt $(Fe_2O_3 . 2SO_3) 2(K_2O . SO_3) 6H_2O$ (Maus).

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* Journ. Pr. Chem., xcix. p. 103; Jahresb. 1866, p. 241.

† Rep. Pharm. [3] i. p. 185.

It is also well known that ferric sulphate is easily formed by oxidation in the air of ferrous sulphate, and that this latter is frequently produced naturally from pyrites through the agency of air, light, heat, and moisture. While the oxidation of ferrous sulphate is in progress, ferric oxide is precipitated.

This ferric oxide is soluble in the simultaneously produced ferric sulphate, giving rise to a series of basic ferric sulphates which are more or less insoluble, and most of which have been but little and very imperfectly studied by chemists.

From what we have just stated, it is clear that, beginning with a solution of ferrous sulphate and submitting it to oxidation under varying circumstances, almost any of the possible basic ferric salts may be produced. If we begin with a lode of superficial deposit of iron pyrites, exposed to the action of air and moisture (preferably warm), and situated at such a distance from the sea and at such an altitude that the escaping drainage from the lode would have sufficient fall and sufficient distance to travel; or if it be collected into a pool or lake so as to allow its ferrous salts to be more or less perfectly converted by long exposure into ferric salts, we have all that is required to explain the formation of such a basic sulphate as that of the mineral cyprusite. It is true that the mineral contains sulphate of alumina, but I am inclined to consider this rather as an accidental admixture. Most of the surrounding rocks are highly aluminous,* and from the fact that on the ground, at a short distance from and lower down than these deposits of cyprusite, there occur great incrustations or efflorescences, as noticed by Dr. Reinsch and myself, of soluble sulphate of alumina, one can scarcely doubt that this soluble salt is being slowly dissolved out of the cyprusite deposit, leaving behind the insoluble tribasic ferric sulphate, admixed with organic silica. The further fact that various specimens of the cyprusite, analysed by Mr. Fulton, contained varying proportions of alumina and sulphuric acid confirms this. The sulphate of alumina probably at first came there by spontaneous evaporation of the mother-liquors after the upheaval of the bed, or the drying up of the stream or deposit in which it had collected.

We have therefore only to imagine at first a stream of water issuing or oozing from a pyrites lode, and carrying with it in solution the products of decomposition of the lode and its walls, ferrous sulphate with aluminic sulphate. As the solution passed over the rocks, or lay exposed *in situ*, the ferrous sulphate would, under the actinic influence of warm sunshine, be more or less completely converted into ferric sulphate, depositing at the same time hydrated ferric oxide. This latter, acted upon by the mixed solution of ferrous and ferric sulphates, will readily form any or all of the possible basic ferric sulphates.

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* An analysis of the compact dolerite or melaphyre, often altered into wake, of this region, gives 54·90 per cent. of silica, 26·19 per cent. of alumina, and 14·53 per cent. of peroxide of iron as its composition. The percentage of alumina is higher than in any other rock of this class known to me.

Looking at the cyprusite from a geogenetic aspect, we must admit that depression below the level of the sea and subsequent upheaval at a later period must have taken place to explain its present situation and its contained marine organic remains.

Possibly great fissures, corresponding to the position of the lodes, may have previously existed in the estuaries of streams or bottoms of small lakes or pools. These, for a long time, may have been inaccessible to the sea and to the marine polycistins (Radiolaria), and the ferrous and ferric sulphates may have been subjected to the reducing action of organic matter, restoring them to their original form, disulphide of iron, which would be deposited in the fissures. Once the fissures were so filled up, geological depressions may have admitted the sea with its living organisms, and thus entirely altered the conditions. The reducing agent being removed, the basic ferric sulphates would be deposited above the pyrites, and the polycistins, poisoned by the soluble salts of iron and alumina, would supply the existing organic silica.

The fact of the cyprusite occupying only the upper portion of the deposit is attributable to the fact that alteration of the lode had only progressed to a limited extent at the time of its submersion.

The formation contains tens of thousands of tons, and is certainly a very remarkable one in every respect. It seems unique of its kind in the world, and deserves a more complete study than I could bestow upon it in a flying mule-back visit to the Chrysophou district during the hottest and most trying period of the year, and while engaged on professional work.*

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* I forward a few slides of cyprusite for the cabinet of the Society, prepared for microscopical examination, as well as some slides of the insoluble residue after treatment with acids, showing the polycistins; also some of the crude material as well as some of the organic silica washed out of it, for distribution to Fellows interested in this branch of research.

# VI.—*List of Desmidieæ found in gatherings made in the neighbourhood of Lake Windermere during* 1883.

By J. P. BISSET.

(*Read 9th January*, 1884.)

PLATE V. FIGS. 4–7.

IN April last Mr. James Bisset, of Yokohama, then temporarily residing at Bowness, sent the writer squeezings from marshy ground in the following localities, viz.:—Moor near the farm of Lindeth, Bowness, and on Brantfell; also from the neighbourhood of Claife Heights and Blea Tarn. These gatherings proved rich in *Desmidieæ*, producing among other interesting forms the beautiful *Micrasterias brachyptera* of Lundell, not previously recorded out of Sweden and Norway. The writer subsequently visited the same district, and made gatherings at Lindeth, through Easedale, and in the neighbourhood of Angle Tarn and Low Tarn. The following list gives the forms detected in the two sets of gatherings, and bears evidence that the English Lake District is likely to be found a very prolific field for these beautiful organisms.

Some particulars and figures are given of supposed new forms found in the gatherings, but which had previously been found in Scotland by the writer and his co-worker, Mr. John Roy, of Aberdeen.

The following authorities are quoted for forms named, or figured, since the publication of the last English work on *Desmidieæ*, viz. by Mr. Archer, in Pritchard's 'Infusoria.'

Archer, Dublin Nat. Hist. Rev. = W. Archer, Dublin Natural History Review 1859.
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De Not. Desm. Ital. = G. De Notaris, Elementi per lo Studio delle Desmidiacee Italiche. Genova, 1867.
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Nägeli, Gatt. einzell. Alg. = C. Nägeli, Gattungen einzelliger Algen. Zurich, 1849.
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Nords. Desm. Arct. = O. Nordstedt, Desmidieæ Arctoæ. Stockholm, 1875.
Nords. Desm. Bras. = C. F. O. Nordstedt, 18 Fam. Desmidiaceæ, Symbolæ ad Floram Brasiliæ Centralis cognoscendam, edit. Eug. Warming. Kjöbenhavn, 1869.

Rabenh. Fl. Eur. Alg. = L. Rabenhorst, Flora Europæa Algarum aquæ dulcis et submarinæ, Sectio III. Lipsiæ, 1868.
Reinsch, Die Algenflora = Paul Reinsch, Die Algenflora des mittleren Theiles von Franken. Nürnberg, 1867.
Reinsch, Contributiones = P. F. Reinsch, Contributiones ad Algologiam et Fungologiam. Lipsiæ, 1875.
Wille, Fersk. Nova. Seml. = N. Wille, Ferskvandsalger fra Novaja Semlja samlede af Dr. F. Kjellman paa Nordenskiölds Expedition 1875. Stockholm, 1879.
Wille, Norges. Fersk. = N. Wille, Bidrag til Kundskaben om Norges Ferskvandsalger. Christiania, 1880.
Wittrock, Om Gotlands = V. B. Wittrock, Om Gotlands och Ölands Sötvattensalger. Stockholm, 1872.

## DESMIDIEÆ Kütz.

### *MICRASTERIAS* Ag.

| | | |
|---|---|---|
| 1. | *M. angulosa* Häntzch | Lindeth and Low Tarn. |
| 2. | *M. denticulata* Bréb. | Common. |
| 3. | *M. Thomasiana* Archer | Lindeth. |
| 4. | *M. rotata* Grev. | Ditto. |
| 5. | *M. brachyptera* Lundell (Desm. Suec. p. 12, t. i. fig. 4) | Lindeth. |
| 6. | *M. papillifera* Bréb. | Brantfell and Lindeth. |
| 7. | *M. Crux-Melitensis* Ehrb. | Lindeth. |
| 8. | *M. pinnatifida* Kütz. | Lindeth and Claife Heights. |
| 9. | *M. crenata* Bréb. | Frequent. |
| 10. | *M. truncata* Corda | Ditto. |
| 11. | *M. mucronata* Dixon | Easedale and Angle Tarn. |

### *EUASTRUM* Ehrb.

| | | |
|---|---|---|
| 1. | *E. verrucosum* Ehrb. | Brantfell and Lindeth. |
| 2. | *E. pectinatum* Bréb. | Frequent. |
| 3. | *E. gemmatum* Bréb. | Ditto. |
| 4. | *E. oblongum* Grev. | Ditto. |
| 5. | *E. crassum* Bréb. | Ditto. |
| 6. | *E. ventricosum* Lund. (Desm. Suec. p. 18, t. ii. fig. 2) | Low Tarn. |
| 7. | *E. pinnatum* Ralfs | Frequent. |
| 8. | *E. affine* Ralfs | Low Tarn. |
| 9. | *E. ampullaceum* Ralfs | Easedale. |
| 10. | *E. Didelta* Ralfs | Frequent. |
| 11. | *E. cuneatum* Jenner | Lindeth, Blea Tarn, and Easedale. |
| 12. | *E. ansatum* Ehrb. | Frequent. |
| 13. | *E. sinuosum* Lenorm. (*E. circulare* β Ralfs) | Low Tarn. |
| 14. | *E. insigne* Hass. | Lindeth, Easedale, and Angle Tarn. |
| 15. | *E. rostratum* Ralfs | Common. |
| 16. | *E. elegans* Bréb. | Ditto. |
| 17. | *E. erosum* Lundell (Desm. Suec. p. 22, t. ii. fig. 6) | Frequent. |
| 18. | *E. binale* Turp. | Common. |
| 19. | *E. insulare* Wittrock (Om Gotlands, p. 49, t. iv. fig. 7) | Lindeth and Angle Tarn. |
| 20. | *E. venustum* Bréb. | Lindeth, Claife Heights, and Angle Tarn. |

### *COSMARIUM* Corda.

| | | |
|---|---|---|
| 1. | *C. margaritiferum* Turp. | Frequent. |
| 2. | *C. reniformis* Ag. | Brantfell, Lindeth, and Claife Heights. |
| 3. | *C. latum* Bréb. | Ditto. |

| | | |
|---|---|---|
| 4. | *C. conspersum* Ralfs | Brantfell and Lindeth. |
| 5. | *C. Botrytis* Bory. | Common. |
| 6. | *C. ochthodes* Nords. (Desm. Arct. p. 17, t. vi. fig. 3) | Brantfell, Claife Heights, and Easedale. |
| 7. | *C. tetraophthalmum* Kütz. | Common. |
| 8. | *C. Logiense* Bisset n.s. | Blea Tarn, Ambleside, Easedale, and Angle Tarn. |

Fig. 4.—Frond shaped as figured, sometimes with a wide and very shallow depression at the ends, deeply constricted and rough all over with small pearly granules. Length, 70–73 $\mu$; breadth 47–50 $\mu$; breadth of isthmus, 21-22 $\mu$. Found previously on Deeside, and in Arran, Scotland.

| | | |
|---|---|---|
| 9. | *C. Brébissonii* Menegh. | Lindeth, Claife Heights, and Easedale. |
| 10. | *C. ornatum* Ralfs | Common. |
| 11. | *C. punctulatum* Bréb. | Frequent. |
| 12. | *C. sportella* Bréb. | Brantfell, Easedale, and Angle Tarn. |
| 13. | *C. speciosum* Lundell (Desm. Suec. p. 34, t. iii. fig. 5) | Easedale and Angle Tarn. |
| 14. | *C. subspeciosum* Nords. (Desm. Arct. p. 22, t. vi. fig. 13) | Lindeth. |
| 15. | *C. Kjellmani* Wille (Fersk. Nov. Seml. p. 42, t. xii. fig. 31) | Ditto. |
| 16. | *C. monomazum* Lundell, var. $\beta$ *polymazum* Nords. (Norges Desm. p. 14, fig. 3) | Ditto. |
| 17. | *C. isthmochondrum* Nords. (Norges Desm. p. 12, fig. 2) | Ditto. |
| 18. | *C. præmorsum* Bréb. (Liste, p. 128) | Angle Tarn. |
| 19. | *C. cælatum* Ralfs | Frequent. |
| 20. | *C. Boeckii* Wille (Norges Fersk. p. 28, t. i. fig. 10) | Lindeth. |
| 21. | *C. crenatum* Ralfs | Common. |
| 22. | *C. undulatum* Corda | Lindeth, Claife Heights, and Low Tarn. |
| 23. | *C. Nymannianum* Grunow (in Rabenh. Fl. Eur. Alg. p. 166; Lundell, Desm. Suec. t. iii. fig. 1) | Angle Tarn and Low Tarn. |
| 24. | *C. Phaseolus* Bréb. | Frequent. |
| 25. | *C. pachydermum* Lundell, var. $\beta$ *minus* Nords. (Norges Desm. p. 18, fig. 7) | Common. |
| 26. | *C. homalodermum* Nords. (Desm. Arct. p. 18, t. vi. fig. 4) | Brantfell and Lindeth. |
| 27. | *C. pyramidatum* Bréb. | Common. |
| 28. | *C. pseudo-pyramidatum* Lundell (Desm. Suec. p. 41, t. ii. fig. 18) | Lindeth and Low Tarn. |
| 29. | *C. variolatum* Lundell (Desm. Suec. p. 41, t. ii. fig. 19) | Angle Tarn and Low Tarn. |
| 30. | *C. granatum* Bréb. | Brantfell and Lindeth. |
| 31. | *C. tetragonum* Nägeli (Gatt. einzell. Alg. p. 119, t. vii. A, fig. 5) | Ditto. |
| 32. | *C. pygmæum* Archer | Frequent. |
| 33. | *C. Meneghinii* Bréb. | Ditto. |
| 34. | *C. angulosum* Bréb. | Ditto. |
| 35. | *C. bioculatum* Bréb. | Ditto. |
| 36. | *C. Jacobsenii* Roy (*C. moniliferum* Jacobsen, Desm. Dane. p. 200, pl. viii. fig. 24) | Brantfell and Claife Heights. |
| 37. | *C. connatum* Bréb. | Brantfell, Lindeth, and Claife Heights. |
| 38. | *C. pseudo-connatum* Nords. (Desm. Bras. p. 214, t. iii. fig. 17) | Brantfell and Lindeth. |

| | | |
|---|---|---|
| 39. | *C. orbiculatum* Ralfs | Frequent. |
| 40. | *C. Portianum* Archer | Common. |
| 41. | *C. amœnum* Bréb. | Ditto. |
| 42. | *C. annulatum* Näg. (Gatt. einzell. Alg. p. 111, t. vi. F.) | Brantfell, Lindeth, and Easedale. |
| 43. | *C. Thwaitesii* Ralfs | Frequent. |
| 44. | *C. quadratum* Ralfs | Ditto. |
| 45. | *C. anceps* Lundell (Desm. Suec. p. 48, t. iii. fig. 4) | Easedale. |
| 46. | *C. Holmiense*, var. *β integrum* Lundell (Desm. Suec. p. 49, t. ii. fig. 20) | Lindeth. |
| 47. | *C. parvulum* Bréb. | Blea Tarn, Easedale, and Angle Tarn. |
| 48. | *C. cucurbita* Bréb. | Frequent. |
| 49. | *C. turgidum* Bréb. | Lindeth. |
| 50. | *C. de Baryi* Archer | Ditto. |
| 51. | *C. cucumis* Corda | Common. |
| 52. | *C. Ralfsii* Bréb. | Easedale. |
| 53. | *C. cyclicum* Lundell (Desm. Suec. p. 35, t. iii. fig. 6 *d*) | Angle Tarn. |

### *ARTHRODESMUS* Ehrb.

| | | |
|---|---|---|
| 1. | *A. convergens* Ehrb. | Frequent. |
| 2. | *A. Incus* Bréb. | Ditto. |
| 3. | *A. octocornis* Ehrb. | Ditto. |

### *STAURASTRUM* Meyen.

| | | |
|---|---|---|
| 1. | *S. muticum* Bréb. | Common. |
| 2. | *S. orbiculare* Ehrb. | Ditto. |
| 3. | *S. brevispina* Bréb. | Brantfell and Lindeth. |
| 4. | *S. mucronatum* Ralfs | Brantfell. |
| 5. | *S. dejectum* Bréb. | Common. |
| 6. | *S. apiculatum* Bréb. | Brantfell. |
| 7. | *S. cuspidatum* Bréb. | Brantfell, Lindeth, and Claife Heights. |
| 8. | *S. Dickiei* Ralfs | Brantfell, Claife Heights, and Easedale. |
| 9. | *S. pterosporum* Lundell (Desm. Suec. p. 60, t. iii. fig. 29) | Angle Tarn and Low Tarn. |
| 10. | *S. O'Mearii* Archer | Brantfell. |
| 11. | *S. avicula* Bréb. | Ditto. |
| 12. | *S. brachiatum* Ralfs | Claife Heights. |
| 13. | *S. læve* Ralfs | Claife Heights, Easedale, and Angle Tarn. |
| 14. | *S. levispinum* Bisset, n. s. | Low Tarn. |

Fig. 5.—*a*, front view; *b*, end view. Frond as figured. Length, 28–30 $\mu$; breadth, 32–35 $\mu$; breadth of constriction, 9 $\mu$. First found in 1882 in Arran, Scotland.

| | | |
|---|---|---|
| 15. | *S. tricorne* Bréb. | Brantfell and Lindeth. |
| 16. | *S. asperum* Bréb. | Brantfell, Lindeth, and Easedale. |
| 17. | *S. Kjellmani* Wille (Fersk. Nova. Seml. p. 50, t. xiii. figs. 50–53) | Blea Tarn, Easedale, and Angle Tarn. |
| 18. | *S. hirsutum* Ehrb. | Brantfell, Blea Tarn, and Easedale. |
| 19. | *S. Pringsheimii* Reinsch (Die Algenflora, p. 172, t. x. fig. 4) | Lindeth. |
| 20. | *S. alternans* Bréb. | Brantfell and Claife Heights. |
| 21. | *S. margaritaceum* Ehrb. | Angle Tarn and Low Tarn. |
| 22. | *S. Brébissonii* Archer | Lindeth and Low Tarn. |
| 23. | *S. teliferum* Ralfs | Frequent. |
| 24. | *S. nitidum* Archer (Dublin Nat. Hist. Rev. p. 3, pl. i. figs. 3, 4) | Lindeth. |

| | | |
|---|---|---|
| 25. | *S. Meriani* Reinsch (Die Algenflora, p. 160, t. xii. fig. 1) | Blea Tarn and Ambleside. |
| 26. | *S. capitulum* Bréb. forma *Spetsbergensis*, Nords. (Desm. Spets. p. 39, t. vii. fig. 25) | Blea Tarn. |
| 27. | *S. monticulosum* Bréb. | Brantfell, Lindeth, and Easedale. |
| 28. | *S. maamense* Archer (Dub. Mic. Club Proc. p. 282, vol. i. 1868); *S. pseudo-crenatum* Lundell (Desm. Suec. p. 65, t. iv. fig. 4, 1871) | Lindeth. |
| 29. | *S. furcatum* Ehrb. | Blea Tarn and Low Tarn. |
| 30. | *S. inflexum* Bréb. | Lindeth and Claife Heights. |
| 31. | *S. polymorphum* Bréb. | Common. |
| 32. | *S. Reinschii* Roy ("St. spec." Reinsch, Contribut. p. 86, t. xvii. fig. 5) | Blea Tarn and Angle Tarn. |
| 33. | *S. oxyacantha* Archer | Lindeth. |
| 34. | *S. aculeatum* Ehrb. | Frequent. |
| 35. | *S. vestitum* Ralfs | Lindeth and Claife Heights. |
| 36. | *S. gracile* Ralfs | Ditto. |
| 37. | *S. paradoxum* Meyen | Lindeth, Claife Heights, and Low Tarn. |
| 38. | *S. tetracerum* Kütz. | Brantfell, Lindeth, and Claife Heights. |
| 39. | *S. furcigerum* Bréb. | Brantfell. |
| 40. | *S. tumidum* Bréb. | Lindeth, Claife Heights, and Blea Tarn. |

### *XANTHIDIUM* Ehrb.

| | | |
|---|---|---|
| 1. | *X. aculeatum* Ehrb. | Low Tarn. |
| 2. | *X. fasciculatum* Ehrb. | Brantfell. |
| 3. | *X. antilopæum* Bréb. | Lindeth, Claife Heights, and Low Tarn. |
| 4. | *X. cristatum* var. *β uncinatum* Bréb. | Brantfell. |
| 5. | *X. Smithii* Archer | Brantfell, Lindeth, and Easedale. |
| 6. | *X. armatum* Bréb. | Common. |

### *TETMEMORUS* Ralfs.

| | | |
|---|---|---|
| 1. | *T. Brébissonii* Menegh. | Common. |
| 2. | *T. granulatus* Bréb. | Ditto. |
| 3. | *T. lævis* Kütz. | Frequent. |

### *CLOSTERIUM* Nitzsch.

| | | |
|---|---|---|
| 1. | *C. didymotocum* Corda | Frequent. |
| 2. | *C. striolatum* Ehrb. | Ditto. |
| 3. | *C. intermedium* Ralfs | Brantfell, Lindeth, and Claife Heights. |
| 4. | *C. Cynthia* De Not. (Desm. Ital. p. 65, t. vii. fig. 71) | Claife Heights. |
| 5. | *C. costatum* Corda | Frequent. |
| 6. | *C. angustatum* Kütz. | Lindeth and Low Tarn. |
| 7. | *C. juncidum* Ralfs | Common. Forms *α* and *β* at Lindeth. |
| 8. | *C. Lunula* Müller | Ditto. |
| 9. | *C. Ehrenbergii* Menegh. | Brantfell. |
| 10. | *C. turgidum* Ehrb. | Lindeth and Low Tarn. |
| 11. | *C. lineatum* Ehrb. | Brantfell. |
| 12. | *C. attenuatum* Ehrb. | Brantfell, Lindeth, and Low Tarn. |
| 13. | *C. Leibleinii* Kütz. | Common. |
| 14. | *C. Dianæ* Ehrb. | Frequent. |
| 15. | *C. Jenneri* Ralfs | Brantfell, Lindeth, and Easedale. |
| 16. | *C. rostratum* Ehrb. | Brantfell, Lindeth, and Low Tarn. |
| 17. | *C. setaceum* Ehrb. | Brantfell, Lindeth, and Claife Heights. |
| 18. | *C. acutum* Lyngb. | Common. |

### *CYLINDROCYSTIS* Menegh.

| | | |
|---|---|---|
| 1. | *C. Brébissonii* Menegh. | Frequent. |
| 2. | *C. diplospora* Lundell (Desm. Suec. p. 83, t. v. fig. 7) | Brantfell and Claife Heights. |

### *PENIUM* Bréb.

| | | |
|---|---|---|
| 1. | *P. Digitus* Ehrb. | Common. |
| 2. | *P. lamellosum* Bréb. | Brantfell and Lindeth. |
| 3. | *P. interruptum* Bréb. | Frequent. |
| 4. | *P. closterioides* Ralfs | Ditto. |
| 5. | *P. Navicula* Bréb. | Ditto. |
| 6. | *P. margaritaceum* Ehrb. | Brantfell, Lindeth, and Claife Heights. |
| 7. | *P. cylindrus* Ehrb. | Lindeth. |
| 8. | *P. polymorphum* Perty | Common. |
| 9. | *P. minutum* (*Docidium minutum*) Ralfs | Ditto. |
| 10. | *P. lagenaroides* Roy n. s. | Brantfell, Lindeth, and Claife Heights. |

Fig. 6.—Frond shaped as figured. Endochrome in well-marked fillets, five of which are generally seen in front view. Membrane rather sparsely punctate. Length, 95 μ; breadth, 45 μ. Previously found on Deeside and in Arran, Scotland.

| | | |
|---|---|---|
| 11. | *P. cucurbitinum* Bisset n. s. | Lindeth and Blea Tarn. |

Fig. 7.—Frond shaped as figured. Endochrome in fillets, three of which are usually seen in front view. Membrane sparsely punctate. Length, 85–90 μ; breadth, 32–35 μ. This form is not uncommon on Deeside, Scotland.

### *DOCIDIUM* Bréb.

| | | |
|---|---|---|
| 1. | *D. Baculum* Bréb. | Lindeth and Claife Heights. |

### *PLEUROTÆNIUM* Näg.

| | | |
|---|---|---|
| 1. | *P. Trabecula* Ehrb. | Frequent. |
| 2. | *P. clavatum* Kütz. | Brantfell and Lindeth. |
| 3. | *P. truncatum* Bréb. | Brantfell. |
| 4. | *P. nodulosum* Bréb. | Ditto. |

### *SPIROTÆNIA* Bréb.

| | | |
|---|---|---|
| 1. | *S. condensata* Bréb. | Frequent. |
| 2. | *S. obscura* Ralfs | Brantfell and Easedale. |
| 3. | *S. parvula* Archer | Lindeth. |

### *SPHÆROZOSMA* Corda.

| | | |
|---|---|---|
| 1. | *S. excavatum* Ralfs | Frequent. |

### *HYALOTHECA* Ehrb.

| | | |
|---|---|---|
| 1. | *H. dissiliens* Smith | Common. |

### *BAMBUSINA* Kütz.

| | | |
|---|---|---|
| 1. | *B. Brébissonii* Kütz. | Common. |

### *DESMIDIUM* Ag.

| | | |
|---|---|---|
| 1. | *D. Swartzii* Ag. | Brantfell, Lindeth, and Claife Heights. |
| 2. | *D. aptogonum* Bréb. | Brantfell and Lindeth. |

### *GONATOZYGON* De Bary.

| | | |
|---|---|---|
| 1. | *G. Ralfsii* De Bary | Brantfell. |
| 2. | *G. Brébissonii* De Bary | Brantfell, Lindeth, and Claife Heights. |

# VII.—*On the Formation and Growth of Cells in the Genus Polysiphonia.*

By George Massee, F.R.M.S.

(*Read 12th March*, 1884.)

Plate VI.

If the growing point of *Polysiphonia* is examined under a low power, a plano-convex apical cell containing a nucleus is seen, the convex side being uppermost; below this—depending on the rate of segmentation of the apical cell—from two to four thin disk-like segments are superposed; further away from the growing point, as the segments increase in breadth, each is seen to be surrounded by a row of cortical cells, the so-called "siphons," these latter appearing to be absent from the youngest segments lying immediately below the apical cell.

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## EXPLANATION OF PLATE VI.

Fig. 1.—Portions from growing point of *Polysiphonia urceolata*, showing the protoplasmic threads connecting superposed segments. The cell-walls have been removed. ×750 diam.

Fig. 2.—Transverse section through the stem of *P. urceolata* at the point where the protoplasm of the cortical cells is continuous with the protoplasm of the axial cell. ×500 diam.

Fig. 3.—Diagrammatic representation of the protoplasmic portion of the growing point of *P. urceolata*.

Fig. 4.—Transverse section through the stem of *P. fastigiata* at the point where the axial cell is connected with the cortical cells; *a*, tetragonidium; *b*, two cortical cells produced from the tetragonidium by gemmation. The cell-walls have been removed. ×500 diam.

Fig. 5.—Vertical section through the growing point of *P. urceolata*, showing the ingrowth, by degrees, of the transverse walls. The protoplasm has been removed. ×750 diam.

Fig. 6.—Perforated plates of cellulose removed from the openings left in the transverse septa of the axial row of cells in *P. fastigiata*. ×1000 diam.

Fig. 7.—Portion of axial cell of *P. fastigiata*, showing the perforation through the transverse wall at *a*, from which a perforated disk of cellulose similar to fig. 6 has been removed; *b*, minute holes in the cell-wall, through which protoplasmic threads pass from the axial to the cortical cells, as shown in figs. 8 and 9.

Fig. 8.—Transverse section through an axial cell of *P. fastigiata* at the point where the protoplasm is giving off rays, *a*, to the cortical cells. The cell-wall is thickened and stratified. ×750.

Fig. 9.—Vertical section of axial cell of *P. fastigiata*, showing stratified cell-wall and protoplasm giving off rays, *a*, to cortical cells. ×750.

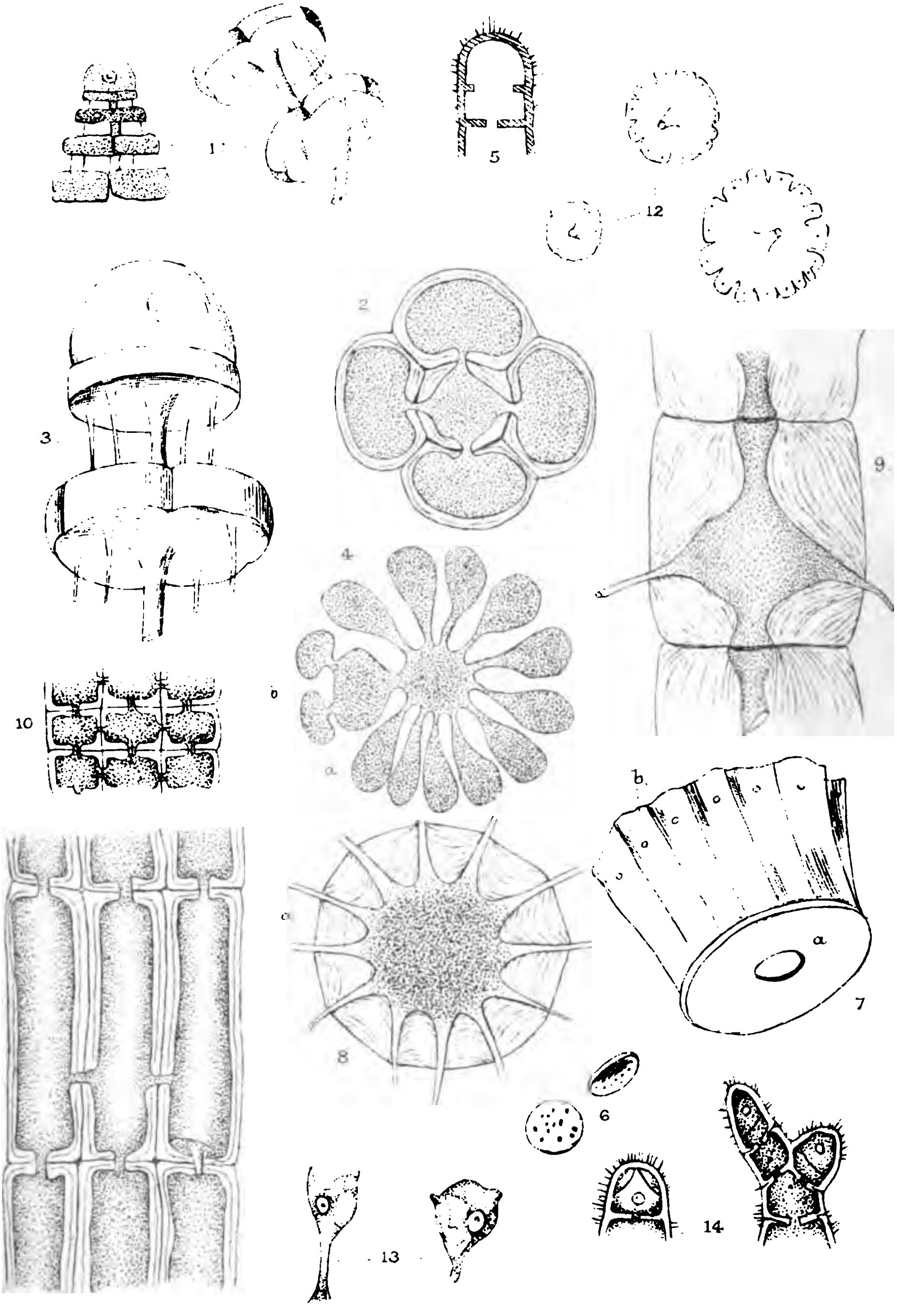
Fig. 10.—Vertical section through a branch of *P. urceolata* a short distance from the apex; the cells have grown considerably in a radial direction, but very little vertically. ×750.

Fig. 11.—Vertical section through a branch of *P. urceolata* at some distance from the apex, showing vertical growth of cells. ×750.

Fig. 12.—Axial cells from *P. fastigiata* close behind the apical cell, showing the origin of cortical cells by gemmation. ×1000.

Fig. 13.—Young tetragonidia from *P. fastigiata*. ×1000.

Fig. 14.—Growing points of *P. fastigiata*, showing method of segmentation of apical cell for formation of a dichotomy.



G Massee del
West Newman &C° lith.

Formation and Growth of Cells in Polysiphonia.

To understand clearly the structure of the growing point, it is necessary to examine specimens from which the cell-walls have been removed: this can be accomplished by soaking for several hours in a solution of nitro-picric acid. If this material is stained and examined under a high power, it will be seen that the protoplasm of each cell is in perfect continuity with the next above and below, being connected by a narrow neck of protoplasm. In addition to this central string, which is comparatively thick and strong, much finer threads may sometimes be seen springing from one of the masses of protoplasm just within its margin, and joining on to the next mass in the same position.

These marginal strings were for some time a source of much perplexity, as owing to their extreme tenuity they rarely survived, unbroken, the treatment necessary for the removal of the cell-walls, and, if broken, the protoplasm contracts so much, that not a trace of the torn ends remain. (Pl. VI. fig. 1.)

If a small amount of pressure, combined with a rotatory movement, be applied to the thin glass cover protecting the specimen under examination, the segments of some of the growing points will be separated from each other. Examined in detail, these segments in *Polysiphonia urceolata* present the following appearance. The first below the apical cell resembles a thin circular disk with an unbroken margin; the second working backwards from the apex is slightly thicker than the preceding, and the margin has four notches at equal distances; these notches, in the third segment, reach about half-way from the centre to the circumference of the disk, which thus presents the appearance of a Maltese cross; in the segments further back, the four lobes are more or less quadrate in form, and each is joined to the central mass of the segment by a narrow neck of protoplasm (fig. 2). The central mass of the segment developes into the axial cell of one joint of the stem, and the four outgrowths form the four cortical cells. The slender threads, alluded to as springing from near the margin of the disk, are in *P. urceolata* four in number, and unite the superposed cortical cells of adjoining segments. The cortical cells are thus connected with each other by vertical protoplasmic threads, each one again communicating with the axial cell by a horizontal thread, while the axial cells, as already shown, are connected by vertical threads (fig. 3). This mode of formation of the cortical cells, as also their connection with each other and with the axial cell, is the same in all the species of *Polysiphonia* that I have had an opportunity of examining.

The tetragonidia originate in precisely the same way as the cortical cells; in *Polysiphonia fastigiata* they occupy a space equal to two of the latter, from which they are readily distinguished, even in the earliest stages of development, by their more spherical form, and by the presence of two prominences on the peripheral margin, which develope into cortical cells (fig. 4); thus the tetragonidia are imbedded in the substance of the thallus, being in communication, by means of a neck of protoplasm, with their mother-cell on the axial side, and with the two cortical cells on their peripheral side, these last being daughter-cells of the tetragonidium. These outgrowths from the tetragonidia originate by the method of cell-division known as gemmation, appearing as minute papillæ, which increase in size and become constricted at the point of attachment with the mother cell. The cortical cells and tetragonidia that originate from an axial cell are also the results of gemmation. It will thus be seen that the increase in size of a *Polysiphonia* is the result of two distinct methods of cell-formation; the axial row of cells, by which the plant increases in length, being the result of fission or segmentation of the apical cell, whereas all increase in thickness is due to gemmation from the axial cells. The manner in which the continuity of protoplasm between adjacent cells is kept up varies with the age of the cells. When a segment is cut off from the apical cell, the partition wall is formed gradually (fig. 5), but before reaching the centre its growth ceases, so that a circular opening is left through which the contracted neck of protoplasm passes unbroken. This opening increases in size with the growth of the cell, being much larger in old than in young cells. After the openings have reached a certain size, they are closed by the growth of a cellulose plate, to the margin of which the protoplasmic sac or "primordial utricle" is attached; this plate is perforated with minute holes through which slender threads of protoplasm pass. The attachment of this plate to the margin of the original large opening is not very firm and it can be readily removed, when it presents the appearance of a flat or convex disk (fig. 6).

The first increase in size of the cells is in a radial direction, the stem attaining its full thickness at a short distance behind the growing point (fig. 10); afterwards the cells rapidly increase in length by acropetal and basipetal growth, the rate of each being shown by the relative length of the cell above and below the neck of protoplasm connecting it with the axial cell, which may be looked upon as a fixed point (fig. 11). After the cell has reached its full development, the protoplasm disappears, leaving the empty contracted protoplasmic sac; the cell-wall at the same time increases in thickness, stratification being in most species very distinct (figs. 8, 9).

The method of branching is dichotomous, segments being cut off from the apical cell by inclined septa (fig. 14), the axis of growth of the branch being at right angles to the septum which cuts off the first cell of the branch from the apical cell.

# SUMMARY

OF CURRENT RESEARCHES RELATING TO

# ZOOLOGY AND BOTANY

*(principally Invertebrata and Cryptogamia),*

# MICROSCOPY, &c.,

INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Development of the Optic and Olfactory Organs of Human Embryos.**†—A. Kölliker has had the opportunity of examining four human embryos, the smallest and youngest of which was 8 mm. long and 4 weeks old, the largest and oldest 21 mm. and 8–9 weeks. The earliest had the lens-pit still open, and the two layers of the secondary optic vesicles were not fused; the proximal of these layers consisted of at least two layers of cells, and showed in its anterior two-thirds fine, round, and proportionately large pigment-granules, and there was a double limiting membrane; the distal or retinal layer consisted of subequal elongated cells, arranged in from four to six layers, its limiting membrane passed directly into the upper of the above-mentioned limiting membranes of the pigment-layer. The lens appeared to consist of two or three layers of elongated cells, while the epidermis was uni-laminate. The vitreous body had the appearance of a well-developed transparent layer richly provided with cells; these were all stellate or spindle-shaped. Sections of the hinder regions showed that the choroidal fissure advanced from below and forwards.

In the next embryo the lens was constricted off, though in size that embryo was only 8·5 mm. long; in some points it showed an advance, and in others it lagged behind the rather smaller embryo, so that it seems that the early developmental stages of the eye vary somewhat in rapidity. After describing the characters of this rudimentary organ the author gives a very useful enumeration of the seven well-observed cases of eyes in embryos not exceeding 8·5 mm.; he then passes to the third embryo, in which the lens-substance is beginning to be developed; it presents a stage in formation which has never yet been recorded. The distal layer of the optic cup now exhibits the first indications of striation, and an inner thinner layer of cells with more rounded nuclei may be distinguished from an outer thicker one in which the nuclei are more elongated; between them lies a clearer zone, poor in cells. The primitive optic nerve is still hollow, though signs of closure are very apparent; it consists partly of the primitive elements of the medullary plate, and partly of very fine longitudinal fibrils which are superficial in position, and extend through the whole length of the nerve. The pigment-layer was intensely brown, and in its thinnest part consisted of two layers of cells. The lens presented the condition in which the lens-fibres had begun to be formed from the cells of the hinder wall of the primitive vesicular rudiment; the capsule was very distinct, and of the same thickness throughout. A distinct cornea was already present, and, in nature, clearly stands in direct contact with the lens-capsule. The mesodermal tissue around the eye was thickened, but was not yet marked off externally.

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* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Verh. Phys.-med. Gesell. Würzburg, xvii. (1883) pp. 229–57 (4 pls.).

The oldest embryo had a spherical lens, the anterior aqueous chamber, and eyelids; the optic nerve exhibited no sign of any cavity, and consisted only of the network of stellate cells derived from the primitive nerve, and very fine non-nucleated optic fibrils; the lens had lost all cavity within, the retina consisted anteriorly of elongated cells, and here and there zones poor in or free of nuclei could be made out. The uvea and sclerotic were not yet distinctly differentiated, but formed only a somewhat thick tissue around the eye. The cornea was remarkably delicate. There were no signs of lachrymal glands, but the ducts and canaliculi were well developed.

In the youngest embryo the uppermost end of the olfactory pit formed already a blind sac, the true olfactory blind-sac, which becomes later on the uppermost part of the olfactory region; in the oldest, the olfactory pits were connected with the primitive buccal cavity by ducts—nasal ducts, the labial and mandibular clefts were seen to be closed, but the palatal cleft was still open. A study of this specimen shows that the network of stellate cells of the olfactory lobe is converted, either partially or completely, into a nucleated network of fine bundles of the finest olfactory fibrils; that the network of cells grow out from the olfactory lobe either before or simultaneously with its conversion into fibrils; it gives rise to buds of cells which project into the mucous membrane of the nose, while behind these buds it continues to be converted into a fibrillar network. The nucleated fibrillar bundles found in the embryo are the predecessors of the nucleated pale olfactory fibres of the adult. If this description is exact it will follow that the fibres of the olfactory nerve are comparable to the axis-cylinders of other nerves, and their nuclei to the nuclei of nerve-cells. For man, as for other forms, embryology shows that the olfactory lobe is a part of the brain, that the point of origin of the nerves is to be found in the primitive olfactory lobes, that the nerves grow out from the lobes, or from parts derived therefrom, and that the olfactory tract and radices are secondary commissural systems which connect the bulbs with the more distant parts of the brain, and, partly also, with one another.

From the rich possession of nerves by Jacobson's organ in an eight-week old embryo, and their disappearance in older embryos, we may conclude that the organ is now in a rudimentary condition, as compared with what it was in ancestral forms.

**Eggs of Birds.**[*]—Prof. Tarkhanoff records a very interesting inquiry into the structure of the eggs of birds.

He finds that albumen of the eggs of the Insessores (ousel, canary, pigeon, &c.) notably differs from that of the autophagous birds (hens, ducks, geese, turkeys). When boiled it remains translucid; it is fluorescent; its rotation-power on the plane of polarization is feebler; when diluted with much water it does not give a white deposit, but only gives a feeble opalescent coloration to the water; finally it has a stronger basic reaction than the white of the eggs of the hen. It may, however, be transformed so as to become like it by various means, namely, the addition of neutral salts, or of bases, or of concentrated acetic and lactic acids, or even of carbonic acid. The most remarkable fact, however, is that the same result is also arrived at by incubation, and Prof. Tarkhanoff considers that the modifying agency in this case is the yolk; when moderately heated with yolk in closed vessels, during twenty-four hours or more, it is transformed into albumen like that of a hen's egg. As to the manner in which the yolk acts on it, it still remains unsettled; the supposition that the diffusion of salts is the cause of the change proved not to be true; and the cause must be searched for perhaps in the diffusion of gases. The interesting question, as to the albumen of hens' eggs not also undergoing the same stages of development within the ovarium, cannot yet be solved satisfactorily; but during his experiences M. Tarkhanoff observed once the most interesting fact that a small ball of amber introduced into the upper part of the ovarium occasioned the deposition of albumen around the ball, and the formation of a shell, that is, the formation of a quite normal egg with its chalazæ, and other particulars of structure. This observation would thus strongly support the mechanical theory of the formation of the parts of an egg around its yolk.

**Chemical Composition of the Egg and its Envelopes in the Common Frog.**[†]—P. Giacosa, to isolate the envelope, placed the eggs for some hours in lime water, whereupon the envelope dissolved while the yolk settled down to the bottom. The filtered solution, treated with acetic acid of 10 per cent., yielded a flocculent precipitate, which, after repeated washing with acetic acid and pure water, gave by analysis 52·71 per cent. C., 7·1 H., 9·33 N., 1·32 S., and 0·42 ash, whence the author infers the presence of a mucin. This substance resists putrefaction, and does not reduce copper salts till after boiling with dilute sulphuric acid. The author intends to study the products of this decomposition, but as he has not been able to detect the presence of any other bodies, he concludes that the enveloping membrane of frogs' eggs consists of pure mucin. From the oviduct of the frog he also succeeded in extracting a mucin, which though differing from the preceding in centesimal composition, nevertheless agrees with it in all other characters.

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[*] Mém. Soc. Nat. St. Petersburg, xiii. (1883). See Nature, xxix. (1884) p. 461.

[†] Journ. Chem. Soc.—Abstr., xlvi. (1884) pp. 198–9, from Gazetta, xiii. p. 171.

**Zoonerythrine and other Animal Pigments.**[*]—C. de Mereschkowsky gives the results of recent researches on zoonerythrine and other animal pigments. A list of the species in which that naturalist has noted the presence of zoonerythrine includes several members of each of the following, Cœlenterata, Echinodermata, Vermes, Crustacea, Bryozoa, Tunicata, Mollusca, and Pisces, in all 117 species. Zoonerythrine is usually found in the superficial layer, but in some species it occurs in the muscular tissue. Various phanerogamous and cryptogamous plants also contain it. Numerous other pigments are enumerated. One group of these is characterized by the ease with which they can be transformed into zoonerythrine under the influence of certain chemical or physical conditions, such as elevation to the boiling-point, or the addition of a drop of acid; while another group is characterized by the impossibility of transforming them into zoonerythrine.

**Commensalism between a Fish and a Medusa.**[†]—Referring to G. Lunel's paper [‡] on the union of *Caranx* and *Crambessa*, in which he speaks of the commensalism of fishes and Medusæ as something doubtful and unknown, W. Macleay points out that the fact was well known to the Commissioners on the Fisheries of New South Wales, who in their report written nearly four years ago, alluding to the Yellow-tail, *Trachurus trachurus*, say :—" The very young fry have a most extraordinary and ingenious way of providing for their safety and nutrition at the same time; they take up their quarters inside the umbrella of the large Medusæ, where they are safe from their enemies, and are, without any exertion on their part, supplied with the minute organisms which constitute their food, by the constant current kept up by the action of the curtain-like cilia of the animal."

## B. INVERTEBRATA.

**Annelid Commensal with a Coral.**[§]—J. W. Fewkes records the fact of an annelid commensal with the coral *Mycedium fragile.* The worm occupies a calcareous tube, which, for the greater part of its length, is firmly fixed to the lower side of the coral. In a normal coral colony, the tube opens near the edge of the cupuliform disk of the young coral; the growth of the edge imprisons the worm-tube which, in time, becomes completely surrounded by the living coral. The worm and its tube grow also, and as the tube remains free at its orifice, the worm within is in free communication with the surrounding medium. Sometimes the coral covers in the mouth of the tube, and then the worm perishes: this, however, seems to happen very rarely. The presence of the worm causes an abnormality in the form of the coral, which, when alone, retains throughout life the discoid form of the young. *Porites* is another example of a coral with which worms live and its interior may be often seen to be perforated with worm-tubes.

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[*] Bull. Soc. Zool. France, viii. (1883) pp. 81-97. Cf. Amer. Natural., xvii. (1883) pp. 1301-2.

[†] Abstr. Proc. Linn. Soc. N. S. Wales, 27th December, 1883, p. iii.

[‡] See this Journal, *ante*, p. 35.

[§] Amer. Natural., xvii. (1883) pp. 595-7.

## Mollusca.

**General Account of the Mollusca.***—E. Ray Lankester has an exhaustive article on the Mollusca, which he arranges as follows:—

Phylum Mollusca.

Branch A. Glossophora.
  Class 1. Gastropoda.
    Br. *a*. Isopleura,
      e. g. Chiton, Neomenia.
    Br. *b*. Anisopleura,
      e. g. Limpet, Whelk, Snail, Slug.
  Class 2. Scaphopoda, e. g. Tooth-shell.
  Class 3. Cephalopoda.
    Br. *a*. Pteropoda, e. g. Hyalæa, Pneumodermon.
    Br. *b*. Siphonopoda, e. g. Nautilus, Cuttles, Poulp.

Branch B. Lipocephala.
  Class 1. Lamellibranchia.
    e. g. Oyster, Mussel, Clam, Cockle.

After a general account of the Mollusca as a phylum of the Cœlomata, the author describes a "schematic mollusc"; it has a head on which are placed a pair of short cephalic tentacles; the apertures of a pair of nephridia are seen to the right and left of the anus; the most characteristic organ is the foot (*podium*) which is probably genetically connected with the muscular ventral surface of the Planarians, and with the suckers of Trematoda. On the dorsal surface is the visceral hump or dome, protected by a shell, which is single, cap-shaped and symmetrical; the integument of the visceral dome forms a primary shell-sac or follicle. The wall of the body forms a flap or skirt—this is the mantle. Underlying this are the ctenidia or gill-combs, to which it is well to give a non-physiological name. Near the base of the stem of each ctenidium is a peculiar patch of modified epithelium, which tests the respiratory fluid and is persistent in its position and nerve-supply throughout the Mollusca; it is the olfactory organ of Spengel and may be definitely known as the *osphradium*. The term "gonad" is applied to the ovaries or spermaries, and it is pointed out that, at present, we cannot say whether the gonad was primitively median, or paired. The disposition of the nerve-cord is highly characteristic. A general sketch of the phenomena of development follows.

The systematic review commences with pointing out the importance from a classificatory point of view of the radula. The Isopleura are divided into the Polyplacophora (Chitons), Neomeniæ, and Chætoderma; the two latter must be associated with the Chitons now that

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* Ency. Brit., xvi. (1883) pp. 632-95 (152 figs.).

Hubrecht has discovered that *Proneomenia* has a radula and odontophore. In the division of the Anisopleura, Spengel's group of Streptoneura, or those in which the nerve-cords share in the torsion of the body, is adopted, and it is divided into the Zygobranchia, in which the organs of the left side do not undergo atrophy—such are the limpet (with regard to whose anatomy much information is given), *Haliotis*, and *Fissurella*; the second order is that of the Azygobranchia in which the left ctenidium and nephridium are atrophied; they are either creeping forms (Reptantia) like *Turbo*, *Turritella*, *Cyclostoma*, *Dolium*, *Conus*, and *Buccinum*, or Natantia like *Atlanta* and *Pterotrachea*. Spengel's name of Euthyneura is also adopted for those Anisopleura in which the tension of the visceral hump does not affect the nerve-cords; here we have the Opisthobranchia and the Pulmonata.

Although the different members of the group of the Cephalopoda differ very greatly among themselves, they are all characterized by the " encroachment of the fore-foot so as to surround the head, and by the functionally important bilobation of the mid-foot. Following the example of his predecessor (Owen) Lankester enters into great detail as to the structure of the Pearly Nautilus.

Various observations of general interest occur throughout the article; the most important is perhaps the description of the nature of the so-called proboscids; the different forms are described and supplied with characteristic designations; indeed the whole essay teems with suggestions of new terms.

It will be noticed that the author now removes the Polyzoa and Brachiopoda from the Mollusca, being led especially by the observations of Caldwell on *Phoronis* to think that the supposed agreement of structure is delusive.

**Intertropical Deep-Sea Mollusca.***—P. Fischer, working at the collections lately made by the 'Talisman,' finds Arctic molluscs at great depths in the intertropical regions of the Atlantic, and points out that the difference between the superficial and the deep fauna is such that the genera are different, that their reciprocal associations have no relation, and that if the remains of these faunæ, although contemporaneous, were to be fossilized, we should say that they belonged to different epochs or represented the population of two distinct seas. With the northern species are found forms that are unknown at present in the northern seas.

As Lovén suspected would be the case, it was found that the bathymetrical limits of the northern forms increased as the equator was approached, and it would appear, therefore, that the temperature of the water has more to do with the distribution of marine animals than the intensity of light.

A number of forms hitherto supposed to be peculiar to the Mediterranean, were found off the coast of Africa; and we may conclude that the number of species confined to that sea are small.

The great depths of Antarctic seas must now be investigated.

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* Comptes Rendus, xcvii. (1883) pp. 1497–9.

**New Cephalopoda.***—A. E. Verrill, in a supplement to his 'Blake Report' describes, among others, the representatives of two new genera. *Nectoteuthis* is allied to *Stoloteuthis*, but he weakens the effect of his discovery by remarking that "some of the peculiar features of the arms and suckers may be only sexual." *Opisthoteuthis* is most remarkable for the posterior opening of the siphon and branchiæ, which is in correlation with the union of the head and body with the brachial membrane. Both of these new genera are founded on single specimens, and in neither case was the sex of the individual absolutely certain.

Two new species of *Octopus*, *O. punctatus* and *O. bimaculatus*, are described in a succeeding communication; with regard to the former the observations of Mr. Dall are of great interest. "When angry, the horn over the eye is erected, the arms coil together, the eye dilates, and the body quivers with rage. The muscles keep up a squirming motion, but I have never seen any approach to the dark colour figured by Chenu as characteristic of the angry *Octopus vulgaris* of the Mediterranean, nor any such elevated longitudinal ridges. The suckers project or are retracted according to the mood of the animal; their outer edge expands when about to seize hold, and contracts after getting hold of anything. . . . It never willingly turns its mouth up, and when forced to do so clenches its arms, like a fist, over it. With death comes flaccidity and flattening. One with a body 8 in. in diameter had the arms 16 ft. long. They shrank much in alcohol." The second species, as represented by its largest known male, has the dorsal arms 325 and 390 mm. long from the mouth; the second pair 540 and 450 mm.; the ventral arms 500 and 490 mm. The diameter of the larger suckers of the lateral arms was 11 to 14 mm.; the body was 70 mm. long, and where broadest, 75 mm.

**Operculum of Gasteropoda.**†—M. Houssay has investigated the question as to what part of the foot of gasteropods excretes the substance of the operculum, and how the growth of that organ is effected. The term *columellar border* is applied to that portion of the operculum which is found near the columella of the shell, and that of *parietal border* to the opposite edge. The internal and external surfaces of the operculum are not formed in the same way. In the latter there is a small transverse cleft, the walls of which are lined by a special epithelial layer, which soon dries in air and becomes of a horny consistency. The cells of the layer secrete a structureless material which gives rise to a hyaline membrane; this escapes by the cleft and becomes added on to the operculum; as these are successively laid down the outer face of the operculum is striated. The inner surface is clothed by an apparently homogeneous layer. The spiral form of the operculum seems to be due to the slight rotation to which it is subjected as the shell grows, and the consequent alteration in position of the columellar muscle. The organ in question is produced by a part only of the epithelium of the foot, and, while it has apparently no relations to the byssus, it is still more different from the second valve of a Lamellibranch shell.

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* Bull. Mus. Comp. Zool., xi. (1883) pp. 105–24 (6 pls.).

† Comptes Rendus, xcviii. (1884) pp. 236–8.

**Anatomy of the Stylommatophora.***—A. Nalepa has been chiefly engaged with *Zonites algirus*, but has also investigated *Limax cinereoniger*, and *Helix pomatia*. The large mucous glands which are so often enormously developed in the integument of land pulmonates are proportionately only feebly developed in, and are indeed absent from parts of the skin of *Zonites*. Transverse sections of the edge of the mantle of *Helix* show conclusively that the *tunica propria* of the mucous glands is continued between the epithelial cells. *Zonites* has no winter operculum, and the absence of this may explain the rare presence of calcareous glands. The author thinks that Simroth's criticism of the supposed olfactory function of the foot-gland is justified by its structure, for maceration shows that it is an agglomeration of unicellular glands. As to the nervous system of the foot, it is to be noted that there are not two primary trunks, inasmuch as the diameter of what have been so regarded is often surpassed by that of their lateral branches.

The different reports that have been made on the distribution of a ciliated epithelium in the enteric canal, are partly, at any rate, to be explained by such facts as that the whole stomach is ciliated in very young Helices, while, in the adult, wide tracts are devoid of cilia. The salivary glands of *Helix* are loose, but in *Limax* and *Zonites* compact masses, which in the former lie like a saddle on the short œsophagus, and in the latter form a pretty broad closed ring; they are made up of a number of unicellular glands, and each cell is surrounded by a membrane of connective tissue, which, at its side, is continued into a narrow and generally very long efferent duct. The cells have either finely granular or hyaline contents, and have a different reaction with osmic acid. Each salivary gland receives a strong nerve from the buccal ganglion, and there is a general distribution of the large ganglionic cells, which are characteristic of the sympathetic system.

The arteries are continued into capillaries with definite walls, lined by a distinct endothelium, but the veins are more lacunar in character, and endothelial cells are absent from their walls. The characters of the circulatory system are described in detail, and attention directed to the discussion as to the closed or lacunar condition of the vascular system of Molluscs. It is believed that the differences in the results obtained depend not only on the imperfection of certain methods of investigation, but also on the vagueness of the ideas of some as to what is meant by a lacuna and a sinus. Although the arteries end in vessels which are comparable to the capillaries of vertebrates, they do not enter into a continuous connection with venous vessels of similar histological constitution; are the continuations lacunæ (or sinuses), or are they modified capillaries? If by "lacunæ" we mean spaces which, in a histological sense, have no wall, then there are lacunæ; but if by the expression we mean to speak of wide-branched cavities in the tissues, the walls of which are merely formed by connective substance, and which have been individualized and made independent of the tissues of the organs, then there are not here lacunæ.

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* SB. K. Akad. Wiss. Wien, lxxxvii. (1883) pp. 237–301 (3 pls.).

In addition to the contractions of the heart, the author has observed rhythmical contractions in the pulmonary vein and its branches. The ventricle is expressly stated to be innervated from a nerve-plexus, which supplies also the aorta, while the auricle appears to be innervated by a pulmonary nerve; after great trouble Nalepa was able to demonstrate nerves in the musculature of the auricle.

After some account of the lung, attention is directed to the kidney, and it is shown that Meckel was in error in supposing that there was a true cameration of the organ, and that the chambers communicated by lateral orifices with the ureter; it seems rather that folds project from its upper and lower walls, but that there is a common central cavity, which, at the tip of the kidney, communicates with the ureter. The lamellæ are ordinarily largely connected by transverse folds, and the spaces thus formed are lined by a secretory epithelium; the uric acid excreted appears to be partly free and partly united with other bodies to form guanin.

The penis of *Zonites* and *Limax* is distinguished from that of *Helix* by the absence of a flagellum; and there are certain differences in the vascular supply. The papillæ of stimulation found in the penis of *Zoonites* consist largely of cells of connective substance, imbedded in intercellular substance, and bounded by the epithelium of the inner surface of the penis. The organ is richly supplied with nerves, as may be well seen in chloride of gold preparations of *Limax*; the ganglionic cells are arranged in groups, are rounded, and have very large nuclei. A glandular mass in the wall of the vagina of *Zonites* corresponds to the digitated mucous glands of the Helicidæ; it consists of tubular follicles which open separately into the vagina, and are lined by a high glandular epithelium. With these the follicles of the bursa copulatoria agree in structure and form.

**Segmental Organs and Podocyst of Embryonic Limacinæ.***— S. Jourdain finds that at the time of the formation of the stomodæal invagination, there appears on either side a *labio-tentacular* thickening, placed in front of the pallial plate. There is a prepallial swelling formed of a central nucleus of granular matter, which the author regards as true post-embryonic yolk-material, destined to make up for the insufficient quantity of primitive yolk. The segmental organ is paired, and is siphonate in shape, the convexity being superior or dorsal; it consists of a membrane lined by polygonal cells with a large granular nucleus, and with very fine cilia; the external orifice is funnel-shaped. It has no relation to the permanent kidney, which is developed independently. The fate of the segmental organ, no vestiges of which are to be found in the adult, has not been determined. The term "podocyst" is applied to the contractile appendage of the hinder part of the mouth, which is either short, as in *Limax agrestis*, or elongated and spiral, as in *Arion rufus*. Its walls are formed by a layer of mesodermal cells with a large nucleus, surrounded by a contractile irregularly stellate protoplasm, the branching processes of which unite with one another. Externally to this layer is a finely ciliated ectoderm; the contained cavity, which exhibits diastole and systole, communicates with the body-cavity, and receives from it and returns to it fluid. Shortly before the young slug leaves the egg the podocyst is completely absorbed. In considering the function of this embryonic organ, we have to note that it is in direct contact with the inner surface of the shell, so that it occupies a very favourable position for the exchange of the necessary gases between the blood and the surrounding air; on the other hand, it is in direct relation to the reserve of material which is used up by the embryo. From a physiological point of view, then, it seems to be comparable to the allantois of the higher Vertebrata.

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* Comptes Rendus, xcviii. (1884) pp. 308–10.

There does not appear to be any good reason for thinking that the prepallial swelling is a contractile sac, which acts antagonistically to the podocyst; all the mesodermal tissues alike distend when the podocyst contracts, and it is only in consequence of the looser texture of the swelling that its movements of dilatation and contraction are more marked and more easily visible.

**Spicula Amoris of British Helices.**[*]—C. Ashford contributes a comprehensive paper on the "darts" found in connection with the reproductive apparatus in certain *Helices*.

The dart is contained in a short ventricose pouch opening into the lower part of the vaginal tube, a little above the common vestibule, on the right side of the neck. There is usually one: if two are present, the second sac is on the opposite side of the tube from the first. The sac may be simple or bilobate. At the bottom of the cavity of the sac is a conical papilla, which serves as a basis for the dart, which is attached to it by its posterior end. The apparatus is a development of adult life, and especially of pairing time, but this is indifferently present or wanting in species otherwise closely allied. The dart itself is a tubular shaft, of carbonate of lime, tapering to a solid, transparent, sharp point, enlarging at or towards the base, where it assumes the form of a subconical cup. The sides of the shaft are sometimes furnished with blade-like longitudinal buttresses, which serve to strengthen it. They are rapidly formed, may be secreted in six days, and differ in form in different species. They are supposed to serve the purpose of inducing, by puncture, the excitement preparatory to pairing. They are too fragile to do more than prick the tough skin of these molluscs, but sometimes penetrate the apertures of the body, and are found within. A new weapon is formed after the loss of the old one. It is best extracted for study by boiling the sac in caustic potash.

**Anatomy of Pelta and Tylodina.**[†]—A. Vayssière gives an account of these small and incompletely known molluscs. The presence of a gill on the right side of the body of *Pelta*, though difficult to demonstrate, proves that that animal is related to the Pleurobranchiata; other characters of its organization justify us in establishing for it a distinct family.

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[*] Journ. of Conch., July 1883. Cf. Science, ii. (1883) p. 803.

[†] Ann. Sci. Nat. Zool., xv. (1883) Art. 1, 46 pp. (3 pls.).

Around the buccal depression there open a large number of mucous glands, not, as in some allied forms, consisting merely of a simple vesicle, but giving rise to mulberry-like masses of racemose character. Each of these masses or aggregates is provided with an excretory duct of some length, and they sometimes not only surround but enter to some extent into adhesion with the nervous centres. The radular apparatus within the buccal bulb does not agree in structure with that of the true Pleurobranchs, and another point of disagreement with them is to be found in the characters of the stomach, which call to mind the arrangements which obtain in the Bullidæ; there are in it four large horny plates, the walls are very muscular, and the whole seems to have the function of a gizzard.

The gill of *Pelta* is not well developed, and possesses only three or four respiratory lamellæ; it is connected with the heart by means of the branchial vein; while the heart and its two aortæ could be made out, the remainder of the circulatory system baffled the investigator. The same remark applies also to part of the reproductive system, but it is of interest to note that the author was able to make some observations on a subject which is just now attracting so much attention—the development of the spermatozoa. He finds that the male vesicles present the appearance of a cell with a nucleus, in which one may distinguish several hyaline granulations; at the periphery of the male cells there are a certain number of granulations, similar to those of the nucleus. This observation leads to the supposition that here, as in *Helix* (Duval), there is an endogenous formation of nuclei. Free from these mother-cells we see a large number of "polyblasts" more or less developed; in one in an advanced stage, each bud or "spermatoblast" is seen to be only connected with the primitive cell by a delicate peduncle which, later on, forms the anterior part of the spermatozoon. The spermatoblasts continue to elongate, until at last we have a large number of spermatozoa which are attached by their heads.

The œsophageal nerve-collar is formed by three pairs of ganglia which are connected with one another by short commissures; of these the cerebroid ganglia are of a pale orange colour, while the pedal and the visceral are more deeply orange. Tentacles being absent, it is possible that olfactory organs are present, but the author was not able to convince himself of this; the eye has the ordinary Opisthobranch structure, while the otocysts are of some size, one only being present in each auditory cell.

The author's investigations lead him to concur in the suggestion of J. E. Gray, that the family *Peltidæ* should be instituted for the reception of this form.

*Tylodina* is next dealt with, and its relations to *Umbrella* are particularly insisted on; differences in the number and form of the teeth of the radula were observed to obtain with age; the stomach is provided with a chitinous triturating apparatus; the commissures connecting the nerve-centres are excessively short, and the cerebroid ganglia are proportionately large, owing possibly to the complete absence of visceral ganglia.

**Absolute Force of the Adductor Muscles of Lamellibranchs.**[*]—F. Plateau has commenced a series of researches on the absolute force of the muscles of invertebrates by an investigation on certain Lamellibranchs. The name of absolute or static force was given by Weber to the force measured by the weight which exactly equilibrates the contraction of a muscle; in other words, if a muscle is fixed by one end, and a weight suspended at the other, the absolute force is measured by the maximum weight which the muscle in action can carry without either elongating or contracting. Hitherto observations seem to have been confined to the frog and to man.

After a notice of the work of preceding investigators into the physiology of Lamellibranch muscles, the author points out that in most of this group the adductor muscles may be found to consist of a transparent (generally the largest) and an opaque portion; the latter appears to be formed of smooth, the former of transversely striated fibres. The experiments of Coutance show that in Pectens the two muscular portions have different functions: while the transparent muscle contracts rapidly, the opaque smooth muscle does so slowly.

Plateau has experimented on twenty different species, but finally limited his researches to *Unio pictorum*, *Cyclas rivicola*, *Artemis exoleta*, *Tellina incarnata*, and *Pandora rostrata*. A full account of the modes of experiment is given, together with elaborate tables of the results; these cannot be reproduced here, and it must suffice to say that it has been found that the only way of usefully comparing the muscular force of Lamellibranchs with that of the higher animals is to discover the absolute force of the muscles for each square centimetre of transverse section. When the comparison is thus made it is found that the absolute force of the adductors of Lamellibranchs is analogous to that of vertebrates. To the objection that molluscan muscles are smooth, and that vertebrate muscles are transversely striated, the only possible answer at this moment is that the author has also made some investigations on the muscular force of Crustacea, which will shortly be published and in which he hopes to explain the apparent anomaly.

**Water-pores of the Lamellibranch Foot.**—H. Griesbach has maintained[†] the existence of *pori aquiferi* in the Lamellibranch foot, while J. Carrière held[‡] the contrary view. J. T. Cattie[§] has studied a considerable number of species, and does not find the least trace of aquiferous pore; and T. Barrois[||] arrives at the same results. He discusses the work of Carrière and himself, and finds that they have studied most of the forms where the presence of aquiferous pores has been claimed, and in every case finds pores absent, or in such position that it seems they are either connected with the functional byssogenous organ, or, where such is absent in the adult, with the remnant of the same. Barrois sums up his views thus :—No pores exist for the introduction of water into the circulation; the only pores of the foot are those connected with the byssus organ, which never communicates with the interior of the foot. The blood may have water introduced into it, but this may be effected by osmosis, or in some manner not discussed.

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[*] Bull. Acad. R. Sci. Belg., vi. (1883) pp. 226–59 (1 pl.).

[†] See this Journal, iii. (1883) p. 353.

[‡] Ibid., p. 639.

[§] Zool. Anzeig., vi. (1883) pp. 560–2.

[||] "Private imprint from Lille, dated October 30th, 1883." Cf. Science, iii. (1884) pp. 130–1.

**Visual Organs in Solen.**[*]—B. Sharp, referring to his recent communication[†] on the visual organs of *Solen ensis*, states that he had since determined the presence of similar organs in the mantles of the clam, the oyster, and the sand-clam. Their presence was made evident by the retraction of the mantles when shadows are passed over them. The structure of the peculiar cells supposed to be primitive eyes, was the same as that of the cells before described in the siphon of *Solen*, including the presence of the transparent portion at the end of each.

### Molluscoida.

**Egg and Egg-membranes of Tunicata.**[‡]—H. Fol finds that the mature ovum of a Tunicate is composed of a granular yolk, containing a female pronucleus, with two polar globules at the surface. A gelatinous layer, containing a very large number of non-nucleated corpuscles, surrounds both the yolk and the globules, while the surface of the whole is occupied by a layer of nucleated cells, which forms the follicle; sometimes this envelope is double, when the outer layer is composed of flattened cells united to form a continuous membrane. The polar globules and the pronucleus are derived from the germinal vesicle, in which a nucleolus, a nuclear plexus, and an envelope could be detected. The corpuscles of the larval testa are homogeneous, and inclose a certain number of large yellowish granulations; at first they are of a vesicular character, but at no time have they a true nucleus; they owe their origin to the superficial portion of the yolk, and arise from it about the time when the egg has attained to half its permanent size. In a *Molgula* these corpuscles were found to be replaced by nucleated cells, which were distended by the homogeneous masses which they contained. The overlying nucleated cells are, in a majority of cases, largely vacuolated, but this appearance is not to be made out before the layer is complete and the cells have been for some time superficial in position; their nucleus arises as a small solid or hollow bud from the germinal vesicle, while the body of the cell is derived from the yolk: when these cells are long in appearing the germinal vesicle is apparent for the whole period; when, on the other hand, they arise rapidly and in large numbers simultaneously, the vesicle rapidly disappears. There is no relation whatever between these constituents of the follicle and the larval test, either as to the time of their appearance, or as to their histological constitution. The granular corpuscles and the gelatinous layer have no relation to the mantle of the adult Tunicata, but form a provisional or larval organ of protection, which in the genus *Doliolum* takes on a fusiform shape, which is at first soft and applied to the body of the larva, but, later on, becomes rigid, and swells out so that it is separated by the gelatinous layer from the contained larva.

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[*] Proc. Acad. Nat. Sci. Philad., 1884. See Science, iii. (1884) p. 237.

[†] See this Journal, *ante*, p. 39.

[‡] Recueil Zool. Suisse, i. (1883) pp. 91-1C0 (2 pls.).

The author postpones for the present a consideration of the views of Sabatier, who, as the readers of this Journal know, has been a great deal occupied with the same subject.

**Simple Ascidians of the Bay of Naples.***—P. A. Traustedt gives a list of the species of simple Ascidians found in the Bay of Naples: in addition to the bibliography and description of the species and genera, there is a classification of the four genera of the Phallusiidæ and of the Cynthiidæ. The new forms described are the ***Phallusia quadrata***, ***oblonga***, ***malaca***, ***pusilla***, and ***ingeria***; and ***Polycarpa mayeri***.

**Urnatella gracilis, a Fresh-water Polyzoan.**†—A paper on this polyzoan, by Professor J. Leidy, has been recently published. It was originally discovered in 1851, and briefly noticed in the same year, and also in 1854, 1858, and 1870. It was found in the Schuylkill River at Philadelphia, but has not been seen elsewhere, except a dried specimen on the shell of a *Unio* from Ohio.

*Urnatella* is a most beautiful form, living in association with *Plumatella* and *Paludicella*, and having similar habits, but is very different from them or any other known fresh-water polyzoan. It is most nearly related to the marine genus *Pedicellina*. It is found attached to the under side of stones beneath which the water can flow. As commonly observed, it consists of a pair of stems divergent in straight lines, or rather gentle curves, from a common disk of attachment. The stems slightly taper, and are beaded in appearance, due to division into segments alternately expanded and contracted. The segments commonly range from two to a dozen, proportioned to the length of the stem, which, when longest, is about the eighth of an inch or a little more. The stems terminate in a bell-shaped polyp, with an expanded oval or nearly circular mouth slanting to one side, and furnished with about sixteen ciliated tentacles. The stems also usually give off a pair of lateral branches from the second segment succeeding the polyp, and frequently likewise from the first segment. The branches consist of a single segment or pedicle supporting a polyp, and usually give off similar secondary branches. The first and second segments are cylindroid, highly flexible, and mostly striated and colourless, and appear mainly muscular in structure. The succeeding segments are urn-shaped; the body of the urn being commonly pale brown, ringed with lines, and marked with dots of darker brown.

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* MT. Zool. Stat. Neapel, iv. (1883) pp. 448–88 (5 pls.).

† Sep. Repr. Journ. Acad. Nat. Sci. Philad., ix. (1883) 16 pp. (6 figs. and 1 pl.). Cf. Science, ii. (1883) pp. 789–90 (2 figs.).

The neck pedicles of the urns are black. The different colours give the stem a beaded and alternately brown and black appearance. Through the lighter coloured body of the urns a central cord can be seen, extending through the length of the stem. The urn-shaped segments exhibit lateral pairs of cup-like processes, which correspond in position with the branches from the terminal pair of segments of the stem, and apparently indicate branches which have separated from the parent-stem to establish themselves elsewhere as new polyp-stocks.

A series of specimens of *Urnatella*—from such as consist only of a simple cylindrical flexible pedicle, supporting a polyp, to those with long stems, consisting of a dozen segments—indicates the urn-shaped segments to be formed through segmentation of the originally single simple pedicle. The segments, therefore, do not correspond with what were polyps; but the terminal polyp is permanent, and the segments originate by division from its neck, very much as the segments of the tape-worm arise from its head. After the destruction of the head, the segmented stem remains persistent; but what becomes of it ultimately has not been determined. Probably the segments may serve the purpose of the statoblasts of other fresh-water Polyzoa. A common mode of propagation of *Urnatella* appears to be by budding, the formation of branches with their terminal polyps, and the detachment of these branches to establish stocks elsewhere. The different specimens apparently indicate this process, though it was not actually observed.

Though the stem of *Urnatella* is invested with a firm chitinous integument, it still retains its flexibility; so that when the polyp is disturbed, it not only closes its bell and bends its head, but the entire stem bends, or even becomes revolute. Sometimes the polyps suddenly twist the stems from side to side, as if they had become wearied of remaining longer in the same position.

**Structure and Development of Argiope.***—A. E. Shipley, after an account of the external characters of the two species of this Brachiopod—*Argiope neapolitana* and *A. cuneata*—which he has been able to study at Naples, describes the structure of the shell, and discusses the nature of the mantle papillæ which make their way into its cavities, the chief function of which appears to be the nutrition of the shell. It is believed that the protrusion of the tentacles is probably effected by the forcing in of a perivisceral fluid, but that their retraction and curling movements are occasioned, in all probability, by the muscular fibres which lie in their interior. There is no anus, and the ileo-parietal band (Huxley) is so feebly developed as to lead to the belief that it cannot afford any support to the intestine; the liver consists of two branched glands, the secreting surface of whose tubules is increased by the elevation of their inner walls into a number of wedge-shaped ridges. Like other recent observers, the author has been unable to find anything like a circulatory organ, or the system of arteries and "accessory pulsatile organs" which have been described by Hancock; the vessels appear to be only slits in the tissue; the blood-corpuscles are large in comparison with the other cells of *Argiope*, "which, like all Brachiopod cells, are extremely small." Respiration appears to be effected by the mantle, and especially in the region of the perforate shell, where a large area is constantly exposed to the currents of water which are set up by the action of the ciliated tentacles.

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* MT. Zool. Stat. Neapel, iv. (1883) pp. 494–520 (2 pls.).

After describing the muscular and nervous systems, the author comes to the female organs, no male having been found by him. There are two pairs of ovaries, one of which is not constantly present; each appears to be formed of a membrane continuous with the body-wall, and covered by epithelium continuous with that of the body-cavity; each ovum is surrounded by a very delicate nucleated capsule. The ripe eggs fall into the body-cavity, where they are taken up by the inner end of the oviduct, whence they pass into the brood-pouches. These last are invaginations of the lateral body-wall. By invagination three cavities are formed in the embryo, which at first communicate at the end near the blastopore, but subsequently become shut off from one another. The central cavity, which is enteric, is, throughout the larval life, without a mouth or anus. The two lateral cavities give rise to the body-cavity, and their walls form the muscles and other mesoblastic structures; sometimes these walls are so much in contact that the body-cavity is obliterated in many places. The embryo becomes divided into two segments, of which the anterior soon becomes again divided; four symmetrically arranged eye-spots now appear, and four bundles of small bristles are soon afterwards developed on the second segment. The stalk of the adult is formed from part of the third segment. A little later the larva escapes from its mother and swims about by the aid of cilia; the setæ and the red colour have probably a protective function.

The author discusses the views of Morse and Kowalevsky, that the Brachiopoda form an order of Vermes closely allied to the Chætopoda, against which he points out that the "segments" of the larva do not seem to have the value of true metameres, but to be due simply to the formation of the shell from the central region of the body; there is no trace of any segmentation of the mesoderm, and no organ exhibits serial repetition. The Brachiopod differs from the Chætopod larva in having an alimentary canal which is not curved, nor divided into three regions, nor provided with mouth or anus; the body-cavity is but feebly developed, and there is no provisional renal organ. Brooks adopts the view of Huxley and Hancock that the Brachiopoda are allied to the Polyzoa; but Shipley points out that (*a*) Balfour has already rendered very doubtful the homologies of the lophophore; (*b*) that the characteristic position of the nerve-ganglia of Brachiopods which remain in the ectoderm, is without parallel in the Polyzoa; (*c*) there are no proper resemblances between their larvæ; and (*d*) the Polyzoa become fixed by the præoral, the Brachiopods by their aboral extremity.

Van Bemmelen would ally the Brachiopods to the Chætognatha, basing his views chiefly on resemblances in histological structure;

to this, however, Shipley attaches little importance, while as to the origin of the mesoblast, he points out that a similar history is found in Echinoderms, Enteropneusta, Chordata, and probably *Peripatus*.

The author does not think that the Brachiopoda and Polyzoa form together a natural phylum; he would rather follow Gegenbaur in making a "primary class" of the Brachiopoda, allied to Mollusca, but more nearly to Vermes.

## Arthropoda.

### α. Insecta.

**Genealogy of Insects.***—This paper, by Dr. A. S. Packard, jun., commences with a diagram illustrating the author's views on the phylogenetic relations of the various groups of insects to each other. The lowest group is that of the Thysanura, and the genus *Scolopendrella*, with its abdominal true legs, probably comes nearest to the hypothetical ancestral form. The Dermatoptera, Orthoptera, and Pseudoneuroptera present in the larval condition more or less close resemblances to Thysanuran genera, and have probably originated from some such forms. The origin of the Coleoptera may probably be traced to some form like *Campodea;* and the arguments for this view are the form of the larvæ of the carnivorous beetles, especially of the Carabidæ, Dytiscidæ, and Staphylinidæ, which display on the whole a more primitive type than those of other beetles; in the phytophagous larvæ the mouth-parts become more aberrant, and often show a tendency to become aborted; and in the weevils the head, mouth-parts, and legs undergo a gradual degradation and atrophy; the phytophagous forms are therefore evidently more specialized and less like the ancestral form than the carnivorous species. The first larva of the oil-beetle (*Meloe*) is very like a *Campodea;* the second larval stage closely resembles a larval Carabid; the third larval stage is again closely similar to the larva of one of the lamellicorn beetles; and, finally, the fourth stage with aborted mouth-parts and legs recalls the larva of the weevils. The metamorphosis of this insect is a kind of shortened epitome of the development of the Coleoptera from some *Campodea*-like ancestor, and the resemblances of its four larval stages to the larvæ of the other Coleopterous genera are stated in a tabular form in Dr. Packard's memoir. Palæontological data are, however, not quite in harmony with this view, since the earliest known beetle is a weevil (the most specialized type) from the carboniferous rocks.

It is also possible that some metabolous Neuropteron may have been the ancestor of the Coleoptera, and the close resemblance of the larva of *Gyrinus* to the larva of *Corydalis* and other Sialidæ favours this view. The three higher orders, Diptera, Lepidopter and a Hymenoptera, had probably a common origin in the Neuroptera; the larvæ of saw-flies and the caterpillars of Lepidoptera are both very like Panorpid larvæ; and the maggots of Diptera, especially the more perfectly developed Culicidæ and Tipulidæ, show considerable affinities to the larvæ of Lepidoptera.

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* Amer. Natural., xvii. (1883) pp. 932–45 (2 figs.).

The embryo bee has a pair of temporary appendages on each segment, as also have the embryos of Coleoptera and Lepidoptera, which points to an early *Scolopendra*-like ancestor, which in its turn indicates a still earlier *Peripatus*-like ancestor from which the Myriopoda and Insecta, at least, if not the Arachnida, have been derived.

**Development of Antennæ in Insects.***—J. Dewitz does not agree with the account of the development of the antennæ of insects given by Graber, who thinks that the point of insertion of the antennæ moves from the ventral to the dorsal aspect of the head. Dewitz finds that if we make a longitudinal section through the head of a half-grown caterpillar, we find an elongated saccular structure at the base of each tentacle; these, which lie below the sutures of the clypeus, are the rudiments of the antennæ of the butterfly. The sac in question is formed by the invagination of the matrix at the base of the caterpillar's tentacle into the interior of the head; the sac is double-walled, and in young caterpillars the two walls are of the same thickness and lie close to one another. Later on, the outer becomes thin and transparent, while the inner becomes folded, as it grows. The orifice of the invaginated sac is at first wide, but later on becomes narrower. Tracheal and other tissues grow into the cavity of the sac, and it is at their expense that the antenna is formed. Between the two walls there is a layer of chitin, which, though very delicate, consists of two lamellæ. The author has not yet been able to determine exactly how the antennæ become free.

**Experiments with the Antennæ of Insects.**†—C. J. A. Porter details some experiments which he has made on the antennæ of insects with the view, if possible, of determining their function, and as the result of these experiments he has been led to the following conclusions:—

1st. The antennæ are not the organs of any one of the so-called five senses, or of any combination of them. It is true that insects often seem to be able to tell the difference between good and bad tasting things brought into contact with the antennæ, but the author does "not think we have any reason for saying that insects taste with their antennæ, because they dislike to have such things as pepper-sauce poured on them, than we would have for concluding that a man tastes with his nostrils simply because he would object to having them filled with the same fluid. But on the other hand, this apparent sense of taste is, in many instances, nothing more than the insect's desire to clean off whatever may be put on its antennæ." They are mostly kept very clean by the insect, and are, as a rule, of all parts of the body most free from extraneous matter. They seldom notice anything put to them unless it be of a nature to adhere to them. But as soon as anything, even pure water, sticks to them, they immediately draw them through the mouth-parts, and if it be anything palatable, as sugar, for instance, they begin to suck at it. But the very fact that often when they get anything distasteful they begin to spit and clean the mouth, is enough to show that they did not get a taste of it before they put it in the mouth. Aside from all this, who ever saw an insect use its antennæ to taste with? Butterflies and similar insects, when probing the deepest flowers, hold them nearly erect. Of many others, such as the bee, wasp, &c., they scarcely reach to the lower part of the head, not to take into account the length of the extended tongue.

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* Biol. Centralbl., iii. (1883) pp. 582–3.

† Amer. Natural., xvii. (1883) pp. 1238–45.

2nd. It does not appear that the power of direction is in the antennæ. It is true that some insects seem to have lost the power of directing their flight when the antennæ are cut off. But besides the fact that many others are not so affected, we know that many of those that are, soon recover and are able to move about as well as ever.

3rd. He is inclined to adopt the opinion of Trouvelot that the antennæ are the organ of some sense not possessed by us, though not one supplementary to that of sight. True, it seems in many cases as though insects deprived of their antennæ are somewhat blind, but in vastly more instances they do not seem so.

**Epidermal Glands of Caterpillars and Malachius.**[*]—The following are the principal results obtained by S. Klemensiewicz.

(1) The eighth and ninth segments of the larvæ of *Liparis*, *Leucoma*, *Orgyia*, and *Porthesia auriflua*, have each a little protuberance on the median dorsal line, with the opening of a gland at the summit. The secretion is clear and odourless; the skin is invaginated at the top of the papilla to form a pendent sac, at the base of which are inserted two muscles running obliquely backwards; and there also open two glands by a common duct. The external surface of the glands is smooth, but in their interior each gland-cell forms a separate bulging mass; the appearance thus presented is singular. The lumen of the duct is very small; its thick walls are formed by two large cells, much like those of the gland proper. In *Leucoma salicis* there are quite similar glands on the fourth and fifth segments. (2) The exsertile horns of *Papilio Machaon*, larva, are described. They are really developments of the tegument. The epidermal cells of their walls are large, and contain numerous rod-shaped bodies; but the cells at the base of the horns are much smaller and glandular (their secretion being probably discharged through pores of the adjacent cuticula). It may be assumed that the odorous secretion accumulates in the invaginated horns, and is freed by their exsertion. (3) The caterpillar of *Harpyia vinula* has a gland in the first segment, opening ventrally. The gland is flask-shaped, the neck acting as duct, and opening into a large transverse fissure; the body of the flask is the gland proper, and is lined by polygonal epithelial cells, with irregularly shaped nuclei; the epithelium rests upon a thin tunica propria. (4) A similar organ to the last mentioned was described in *Vanessa larvæ* by Rogenhofer.[†] It is an invagination of the skin on the ventral side

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[*] Verh. Zool.-Bot. Gesell. Wien, xxxii. (1883) p. 459. Cf. Science, ii. (1883) p. 632.

[†] Ibid., xii. p. 1227.

of the first segment; its cuticula is thin, and forms numerous little cups, under each of which is a thin epithelial cell. (5) The orange-coloured fleshy warts on the sides of the thorax and abdomen of *Malachius* are also glandular. The epidermis presents no special features in the warts, except that it bears scattered unicellular glands of the form typical for insects; they are flask-shaped, with a coiled cuticular duct in their interior, the duct being continuous with a pore-canal through the general cuticula of the wart. In the lower and larger end of each cell lies the round nucleus.

**Classification of Orthoptera and Neuroptera.***—Dr. A. S. Packard, jun., in a preliminary notice abstracted from the forthcoming 3rd report of the U.S. Entomological Commission, considers "the position of the Orthoptera in reference to allied ametabolous insects." The four orders, Neuroptera, Pseudoneuroptera, Orthoptera, and Dermatoptera are united into a "super-order" Phyloptera, the name implying that these insects are closely allied to the primitive form whence all the higher insects (Lepidoptera, &c.) have been derived. The main characters of the Phyloptera are as follows:—mouth-parts free, adapted for biting; mandibles toothed: first maxillæ separate, second maxillæ united to form a labium. This primitive condition of the mouth-parts is also to be seen in larvæ of Coleoptera. The prothorax is generally large, the meso- and metathorax equal in size. The wings are usually net-veined, the hind-wings being often larger than the front pair. The abdomen has ten segments and the rudiments of an eleventh. Metamorphosis is incomplete except in the highest order Neuroptera. The lowest of the four orders are the Dermatoptera and the typical genus *Forficula* combines many characters of the higher group: thus the elytra and hind-wings anticipate those of the Coleoptera, and the larva resembles the Thysanuran *Japyx*; its metamorphosis is even less complete than in the Orthoptera. The next highest group is that of the Orthoptera, and the metamorphosis, though more marked than in the last mentioned, is less marked than in the Pseudoneuroptera, which form the next group. The author divides the Pseudoneuroptera into three sub-orders: (1) Platyptera (Termitidæ, Perlidæ, &c.); (2) Odonata (Libellulidæ); (3) Ephemerina (Ephemeridæ). In the last group the Neuroptera-metamorphosis is complete; this order is divided into two sub-orders, Planipennia (Hemerobiidæ, &c.), and Trichoptera (Phryganeidæ); in the Trichoptera the mandibles are nearly obsolete, thus suggesting or anticipating the Lepidoptera.

The paper concludes with a tabular arrangement of the hexapodous insects divided into super-orders, orders, and sub-orders.

**Sucking Organs of Flies.**†—K. Kräpelin commences with a description of the "proboscis" of *Musca*, in which he points out that the second pair of maxillæ give rise to a conical piece, which has thin walls and can be withdrawn into the firmer parts of the head capsule; the retractile portion may be spoken of as the "cephalic cone," and the lower lip, upper lip, and hypopharynx as the proboscis proper. The former is, superiorly, provided with a pair of simple palps, which appear to be the remnants of the mandibles, the latter has on upper side a deep longitudinal groove, in which lie, one above the other, the two unpaired chitinous stilets.

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* Ann. and Mag. Nat. Hist., xii. (1883).

† Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 684–719 (2 pls.).

The upper of these appears to be the direct prolongation of the superior and anterior edge of the cephalic cone; the free portion can be bent, but the basal part is connected with the head. The hypopharynx is a longitudinally compressed hollow cone, and its groove, opposite to that of the upper lip, unites with it to form a tube which opens into the digestive canal; it is traversed internally by the ducts of the thoracic salivary glands, which open at its tip; the true mouth-opening may be regarded as being placed at the anterior end of the small chitinous capsule, and at the point where the upper lip and the hypopharynx are inserted. The lower lip does not, as in other Diptera, or in Hemiptera, form the true sucking tube, but is a support for it. After describing in great detail all the accessory points, the author passes to the musculature and the mode of action of the proboscis.

The proboscis is drawn into the head by two pairs of muscles, and these, in retracting, cause also a flexion of the lower lip; these strong muscles are aided by two pairs which are less well developed, and one of these seems to effect the double folding which is to be noticed in the basal membrane of the cone. While the action of the above-mentioned muscles is not difficult to understand, it is less easy to see how the protrusion of the proboscis is effected. What is wanted in the way of fulcrum for the muscles seems to be made up for by the disposition of the tracheal system of this region; the limbs which enter the head swell out into (apparently two) large vesicles, which, when the proboscis is protruded, occupy the whole of the internal cavity, so far as this is not occupied by the nerve-centres, optic nerves, and cephalic vesicle. When these contract, room is made for the inpressing fulcrum, without any disturbance of the surrounding organs.

Special movements appear to be confined to the upper lip; it is straightened out by a delicate pair of muscles, which are opposed by another pair, whose chief function would appear to be to bring into contact the two halves of the sucking groove. The movements of the labella are next described, and then the process of sucking is taken up; a fly is not only able to take in fluid, it can also feed itself on solid matters suspended in liquid. This injection of material appears to be effected on the method of the suction-pump, the movable piece being represented by the upper plate of the base of the fulcrum, which, as it is drawn up, carries the fluid into the fulcral canal; the depression of this plate drives the nutriment to either side, unless the anterior portion of the plate has descended first and so formed a kind of safety-valve, in which case the fluid passes backwards into the œsophagus.

Solid substances are dissolved by the action of three pairs of glands, which, in a loose way, are spoken of as salivary; the largest and the best known of these lies in the thorax, and its secretion passes into two ducts, which unite with one another in the head. This unpaired duct passes along the lower side of the fulcrum, traverses the hypopharynx and opens at its tip. Just before it passes into the hypopharynx the duct is provided with a simple valvular arrangement, which regulates the supply of the fluid; there is not, however, any reservoir in connection with this valve, as was imagined by Meinert, nor is there any pump-like arrangement, such as is found in the Hemiptera. A second pair of salivary glands lie at the base of the knob of the proboscis, and form large-celled rounded spheres; the ducts of these glands have, notwithstanding the investigations of Graber, Meinert, and Becher, never yet been discovered; after much trouble the author was able to find their common orifice at the tip of the superior plate of the lower lip; each gland gives off a bundle of fine canals, which finally open into a common efferent duct. The third set of glandular cells which lie near the œsophagus are not provided with a common duct; they open by numerous canaliculi into the œsophagus.

Where the proboscis is not covered by thick chitinous plates it has very thin and short hairs, which are mere projections of the chitinous investment, and are neither hollow nor provided with nerves. In addition to these there are tactile hairs, glandular setæ, and gustatory organs.

The hairs are chiefly developed on the upper edge of the labellar cushions, and have the form of delicate hollow hairs provided with a fine nerve which arises directly from a multicellular ganglion. With these hairs Kräpelin would associate the hairs which have been described by previous authors, and which are placed in two longitudinal rows on the upper lip and pharynx. They do not appear to have, as has been supposed, the function of gustatory organs, but are rather means by which the firm particles that are sucked in may be felt and retained.

The glandular hairs are especially well developed on the outer surface of the labella, and are distinguished by their enormous size; they are cylindrical in form, and have at their base a pyriform thin-walled structure in which a number of rounded cells are inclosed as in a sac. The author cannot agree with Künckel or Gazagnaire in ascribing a nervous character to these bodies, inasmuch as the deep grooves which are found on them speak rather to their glandular and excretory function.

The gustatory organs are placed on the inner face of the labellar cushions, and each forms two pale concentric rings which do not project above the integument, and cannot, therefore, have any tactile function; nerve-fibres, with a contained transparent axial cord, could be made out in thin sections, and the relations of this demonstrated clearly that it was a sensory organ that had to do directly with chemical stimuli. The nerves which supply all the labellar organs form two large limbs in the lower lip. The author hopes to extend his investigations to other forms among the Diptera.

**Visceral Nervous System of Periplaneta orientalis.*** — M. Köstler, after a detailed notice of the work of preceding anatomists, commences with the unpaired visceral nervous system, which can be best studied by the method of sections: he finds in it (1) a frontal ganglion; (2) the nerve on the œsophagus and crop; (3) the large triangular ganglion on the crop; and (4) the two nerves thence given off with their accessory ganglia. In the first of these we find the so-called central dotted substance, and it is surrounded by a layer of ganglionic cells; these last are traversed by a special supporting substance such as Dietl has found in the cerebrum; from the neurilemma surrounding the ganglion fine connective cords pass off in all directions towards the central mass; the ganglionic spheres are always of a larger size than they ever are in the brain; they are rarely pyriform in shape, and never have any investment; the protoplasm is collected into nuclear masses of some size, and a concentric disposition of the layers is easily seen. The spheres are almost always unipolar, bipolar cells being very rare, and multipolar only once observed, and this may have been due to an optic illusion.

The unpaired visceral nerve has exactly the same structure as that of the commissures of the ventral ganglionic chain, and the grey granular fibres call to mind the sympathetics of the Vertebrata. The large ganglion on the crop has a very similar constitution to that of the frontal ganglion.

With this unpaired system there is correlated a paired visceral system of nerves; the development of one standing in opposition to that of the other. It consists of a number of small oval ganglia which lie on either side of the median unpaired nerves, and are connected with the brain; they have the usual fibrillar structure, and have a few elongated ganglionic nuclear masses imbedded in them. Their chief function appears to be to innervate the large salivary glands.

The true sympathetic nerve can be seen by removing the ventral ganglionic chain, and treating it for a short time with the vapour of osmic acid; two sets of nerves will then be distinguished, for the ventral chain will be found to have taken a distinctly dark coloration, while between the longitudinal commissures much lighter nerves are to be seen. Almost in the middle of every such commissure, alternating now to the right, now to the left, there will be seen passing off a fine nerve; at the level of the ventral ganglia this nerve divides into two parts, each of which swells out into a small spindle-shaped ganglion, and then passes into the lateral nerve given off from the ganglion, its own pale fibres mixing with the cerebro-spinal, and taking the same course as the peripheral nerves.

The author thinks that when we make a general comparison between the visceral nervous system of Arthropods and of Vertebrates we can have no doubt that the true sympathetic of the one is that also of the other. Its relation to the ventral chain is reversed indeed. The unpaired nerve is cerebral and corresponds to the vagus, and its grade of development is dependent on that of its possessor, so that in the larval stage, when the organism needs more food, it is larger than it is later on. Differences are to be seen in the disposition of the appended ganglia, but the great ganglion frontale is perhaps a separated portion of the cerebrum, which owes its special position to the development of the anterior portion of the digestive tract.

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* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 572-95 (1 pl.).

**Pulsating Organs in the Legs of Hemiptera.*** — Conflicting opinions have been held regarding the pulsating organs that have from time to time been observed in the legs of certain Hemiptera. W. A. Locy records some observations which enable him to say that these organs are distinct from the muscular system of the legs, and that they influence circulation. Their automaticity was also observed. Specimens for examination were chosen with reference to the transparency of their legs, as it is upon this point the success of observation depends. Both larval and adult forms of the genera studied were used, but the best results were uniformly obtained with the larval forms, for the above reason. In some cases special methods were necessary to render the legs transparent enough for observation. For this purpose the integument of the legs was scraped very thin. The organs can be demonstrated in this manner, even in the thick legs of the adult Belostomæ. They are most easily seen in the legs of *Notonecta* and *Corixa*, but are not so large and pronounced as in the legs of the Nepidæ. In the more transparent individuals not only are the organs readily seen, but the circulation of the blood can be watched with a power high enough to bring out the corpuscles.

### γ. Arachnida.

**Vitelline Nucleus of Araneina.**†— A. Sabatier adopted the following method in his investigation into the structure of the ova of spiders. The animals were opened while alive in a few drops of alcohol, so as to harden and fix the eggs at once; sometimes, though rarely, osmic, picric, or acetic acid was used. The eggs were stained with Beale's carmine or picrocarminate of ammonia; after washing, they were placed in phenicated glycerine.

The vitelline nucleus was observed in all the Araneids examined; its presence is ordinarily marked by its affinity for the colouring matters which are taken up by the yolk. Sometimes, indeed, its presence is only revealed by the existence on its surface of refractive granules which mark out its spherical form. In *Tegenaria agrestis* it is often very distinct.

This nucleus arises in the neighbourhood of, or even in contact with the germinal vesicle under the form of a mass, which, speaking generally, differs from the yolk by being more finely and evenly granular, by a greater affinity for colouring matters, and sometimes by higher refractive power. It has a massive and not vesicular structure; when it does not undergo stratification it consists of a spherical mass of protoplasm, without membrane or nucleolus, and with no chromatin-plexus, though it probably has some chromatin diffused through it. It is possible, but the question must still remain an open one, that it is merely a massive nucleus. It gradually separates itself from the neighbourhood of the germinal vesicle, and passes to the periphery of the yolk; it becomes more granular, and undergoes disintegration; its elements, divided into small globules, independent of one another, are in parts absorbed by the yolk, or gradually become merged in the superficial granular protoplasm. The vitelline nucleus may, therefore, be looked upon as a centrifugal element, which tends to eliminate itself or to lose its "autonomy." Sabatier regards it as an element of male polarity, which is destroyed as such to accentuate and complete the sexuality of the female cell.

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* Amer. Natural., xviii. (1884) pp. 13-9 (1 pl.).

† Comptes Rendus, xcvii. (1883) pp. 1570-2.

**Restoration of Limbs in Tarantula.***—H. C. McCook recently exhibited a tarantula which had been kept in confinement nearly a year, fed during winter on raw beef and in summer on grasshoppers. In the spring it cast its skin by a laborious process, in the course of which it lost one foot and two entire legs. Last summer again, during the latter part of August, the animal moulted; the moult being a perfect cast of the large spider—skin, spines, claws, the most delicate hairs all showing, and their corresponding originals appearing bright and clean upon the spider. The moulting occurred during Dr. McCook's absence, but was just finished when he returned. When the cast-off skin was removed it showed, as might be supposed, the dissevered members to be lacking. But on looking at the spider itself, it was seen that new limbs had appeared, perfect in shape but somewhat smaller than the corresponding ones on the opposite side of the body. The dissevered foot was also restored. The loss of the opportunity to see the manner in which the legs were restored during moult was greatly regretted; but we have some clue from the careful and interesting studies of Mr. Blackwall. Several spiders whose members had been previously amputated, were killed and dissected immediately before moulting. In one of these the leg which was reproduced was found to have its tarsal and metatarsal joints folded in the undetached half of the integument of the old tibia. Another like experiment was made with an example of *Tegenaria civilis*. The reproduced leg was found complete in its organization, although an inch in length, and was curiously folded in the integument of the old coxa, which measured only 1/24 in. in length. Dr. McCook's tarantula had lost both legs close up to the coxæ, and in the moult the hard skin formed upon the amputated trunks was wholly unbroken, showing that the skin had been cast before the new leg appeared. We risk nothing in inferring that, as in the case of Blackwall's *Tegenaria*, the rudimentary legs were folded up within the coxæ, and appeared at once after the moulting, rapidly filling out in a manner somewhat analogous to the expansion of the wings in insects after emerging.

**Morphology of Plumicolous Sarcoptidæ.**†—E. L. Trouessart and P. Mégnin have a second note on this subject, in which they

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* Proc. Acad. Nat. Sci. Philad., 1883, pp. 196–7.

† Comptes Rendus, xcvii. (1883) pp. 1500–2.

point out that, though most plumicolous Sarcoptids are oviparous, some are viviparous (e. g. *Fryana*); the covering of the egg is sometimes tubercular and sculptured, and in *Analges fuscus* has a double row of cells, comparable to the ring of certain sporangia, and forming an organ of dehiscence. The dorsal tegumentary plates are not always granular, as in the species studied by Robin; they are often perforated or reticulated. The nymphs are sometimes found under two forms, which differ in size. The curious red-coloured vesicles which are found on the flanks of a species of *Pterolichus* may be regarded as secondary sexual organs; the female has two, the male one pair. When highly magnified they have the appearance of a flattened uniform plate, formed of a large number of tubes which open into an excretory canal, the orifice of which is lateral or posterior. The red colour is due to a liquid which fills the tubules. They appear to be modified segmental organs, but their function is still unknown.

### δ. Crustacea.

**Sexual Characters of Limulus.***—B. F. Koons has been puzzled by the fact that no cast-off shells of *Limulus* bearing the characteristic modified claw of the male have been found; he now sees that this is to be explained by the young male having the claws of the second pair of appendages similar to those of the female; as no large exuviæ have been found it is probable that the fully grown *Limulus* does not shed his integument. Howsoever young specimens may be, the sexes are to be distinguished by the transverse slits of the oviducts, and the papillæ with terminal circular orifices in the male. Females are larger than males, and the carapace of large specimens is overgrown with algæ, and appears rusty and aged, while those of smaller examples are bright and clean, pointing to their being frequently shed; indeed the covering appears to be shed several times during the first year. While the entire length of the exuvia may be only 4·0 mm. the escaped young measure 7·1 mm.: an exuvia of 7·0 mm. has a naked young of 10·7 mm., while when the shed integument is 29 mm. the escaped young have been found to be as much as 40 mm. in length. Corresponding differences obtain in the different parts of the animal.

**Evidence of a Protozoea Stage in Crab Development.**†—There is great interest attached to speculations as to the probable ancestry of the Decapods, owing to the value which the conclusions have in enabling us to interpret palæontological facts. There have been quite a number of theories advanced as to the original stem from which the Decapods have been derived, two of which claim especial attention. One is the theory of Müller, who finds such a stem form in the zoea. Another, suggested by Claus, or in a different form by Brooks, considers the protozoea as the ancestral stem. It is of great importance in understanding the Crustacea to decide between these two views, inasmuch as by the first view Crustacea are supposed to have descended from a form without a thorax, while according to the second, the thorax was present in the original Decapod stem. Some work done by H. W. Conn, during the last summer, upon the larval cuticle of crabs, indicates conclusively (it is claimed) that the latter view is the correct one, or that at least Fritz Müller's view is incorrect. The larval skin, particularly the telson of a large number of crab zoeas, was studied with the following results.

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* Amer. Nat., xvii. (1883) pp. 1297–9.

† Johns-Hopkins Univ. Circulars, iii. (1884) p. 41.

The larval skin is not in different crabs alike, nor is it in any case exactly similar to the inclosed zoea. There is always an indication more or less complete, of some previously existing stage. There has been shown in the various forms studied a gradation from the larval skin, with little difference from the zoea inclosed, to a larval skin which is utterly unlike the zoea, but which possesses a forked tail with fourteen long feathered spines. This gradation is complete, and a study of the different embryonic telsons shows that all have been derived from the form shown by *Panopeus*, which has a forked tail with fourteen spines. Now, such a larval skin is to be considered simply as the cast-off skin of some stage immediately preceding the zoea. It has been shown by Paul Meyer that the study of the skin of Macroura leads to a similar result, that a forked tail with fourteen spines is also seen in the early history of this group. If, therefore, a form can be found which shows these peculiarities, we have reason for accepting it as the stem form of the higher Crustacea. Now a study of the different protozoea forms which occur in the ontogeny of various Macroura shows that we have in this form a stage which fulfils the conditions. It has the forked tail with fourteen spines and has large swimming antennæ, another peculiar characteristic of the crab larval cuticle. If the various larval skins of crabs and Macroura be compared with each other, it will be seen that they are all to be considered as modifications of a tail much like that present in the larval skin of *Panopeus;* and if this tail be compared with the protozoea tail of *Peneus*, the likeness will be seen to be very striking. We have, therefore, in the comparative study of the larval cuticle of crabs, good reason for accepting as the stem form of the Decapods a form which had resemblance to a protozoea.

**Gastric Mill of Decapods.***—F. Albert has studied the digestive or gastric mill of Decapod Crustacea in great detail, in the descriptions of which he makes use of the nomenclature proposed by Nauck.

The simplest arrangements of the hard parts in the gastric wall of Decapoda are to be found in the prawn-like forms, where, however, there is not so much a primitive type, as well-developed characteristics which it is sometimes difficult to bring into association with the majority of forms, owing to the absence of certain intermediate links. Among the Natantia we find, on the one side, forms in which the cardiac apparatus, and others in which the pyloric part of the organ is best developed. In both cases the same plan has been followed; two paired and lateral teeth have entered into a physiological connection with an unpaired median process. At the end of one line of development we find a superomedian tooth with superolateral structures, and in the other the tooth of the inferomedian pouch is well developed, with its tooth-like lateral processes. The Alpheinæ, Palæmoninæ, Crangoninæ, and Gnathophyllinæ are in common characterized by the fact that the inferomedian and inferolateral regions of the cardiac and pyloric portions are alone provided with hard structures of characteristic form; the inferomedian cardiac process evidently consists of three distinctly differentiated longitudinal portions; of these the median one has few or no setæ, while the lateral portions have short setæ, of various forms and arranged in groups, which look towards the middle line; with this are placed longer setæ which form a continuous fringe, and, when the gastric musculature is well developed, this fringe is provided with special muscles. The effect of this arrangement is to confine the food-particles to the median line, and to drive them along it into the thoracic region of the stomach. Bearing this in mind, we can understand that the loss of the peristaltic action of the stomach is due to the reduction of the cardiac process and the great development of the pyloric superomedian process.

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* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 444-536 (3 pls.).

The author concludes from his elaborate survey that the hard structures of the stomach of the higher Crustacea are most important aids in the classification of these forms; and his own results coincide with those arrived at by v. Boas. The Natantia form the lowest groups, and the Eucyphotes may be defined as Decapods without a cardiac dorsal mill, and the Penæidæ as Decapods provided with one. The Atyinæ appear at present to be isolated forms, but a connecting link may perhaps be found in *Troglocaris*. The Sergestidæ are to be placed with the Penæidæ, as are also the *Cerataspis* forms, which are often associated with Schizopoda. The well-defined group of the Homaridæ may be divided into the Homarinæ and Astacinæ, as Boas has suggested. The Anomala (in the sense of De Haan) do not form a definitely separated group.

The type of gastric mill found in the Decapoda may be continued into the Squillidæ, Mysidæ, and Cumaceæ, where almost all the corresponding parts are to be found. The median inferomedian pyloric process forms a crest-like longitudinal invagination, and passes through very interesting gradations; in *Diastylis* it has one, in *Mysis* two, in *Gammarus* three, and in the higher Malacostraca a number of fringes of longitudinally-set setæ; indeed, the number increases as the form possessing them stands higher in a systematic classification.

**Spermatogenesis in Hedriophthalmate Crustacea.*** — G. Herrmann finds that the spermatogenesis of hedriophthalmate is effected on a different plan to that of the podophthalmate Crustacea. The male cells are of large size, and, soon, come to have a number of nucleoli, around which the nucleus seems to undergo segmentation. This is followed by a stage in which there is a group of smaller nuclei, irregular in form, more or less definitely arranged round the periphery of the sperm-cell ("ovule"). This latter divides into equal parts, and soon small cell-elements, with a nucleus, but without a

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* Comptes Rendus, xcvii. (1883) pp. 1009-12.

nucleolus, appear. The cephalic nodule is now formed, as a small cup-shaped disk, attached to the surface of the nucleus. As in the Vertebrata, the spermatic filaments are developed at the expense of the spermatoblasts, but the cephalic nodule, which in all other animals has an important function, is here only secondary. A little later the spermatozoid is found to consist of three segments—a cephalic, which incloses the spermatoblast and its nucleus, a median segment which is scarcely visible, and a caudal segment or filament. Later on, the nucleus becomes ovoid in shape, with its long axis in an antero-posterior direction; after it has elongated, its hinder extremity separates from the cell-body of the spermatoblast, and it finally leaves the cell. The flagellum becomes of proportionately great size. Eighty to one hundred spermatic filaments are united into bundles, which are placed in the grooves of the epithelial cells which line the walls of the tubes. Isolated spermatozoa have only been found in the oviducts of the female.

With the exception of its cephalic nodule, the spermatozoon of a hedriophthalmate crustacean has very much the same history as that of the Selachians, and it is to be noted that these spermatozoa exhibit a more complete type than those of the Podophthalmata, inasmuch as in the latter they may be reduced to the single cephalic segment.

## Vermes.

**Structure and Division of Ctenodrilus monostylos.*** — M. Zeppelin gives a full account of this new species of marine annelid. It is about 3 or 4 mm. long, and 0·2 wide, and consists of 20–25 well-marked segments, and is of a yellowish-brown colour. It is remarkable for the possession of a protrusible proboscis which is quite independent of the enteric canal. The only pair of segmental organs is found in the head. The buccal cleft is ciliated, as are also the œsophagus and the rectum. All the segments but the last have setigerous sacs, with two or three setæ apiece. They move very slowly. Sexual reproduction has not yet been observed, but only transverse division. The habitat of the worm is not known, the specimens examined having been found in an aquarium at Freiburg.

The cuticle is thin and homogeneous, the hypoderm thick and made up of polygonal cells with scattered pigment-spots. The musculature is of a very primitive character, the dermomuscular tube consisting of a simple layer of longitudinal fibres which extend uninterruptedly to the end of the body; in this point *C. monostylos* has a striking resemblance to *Polygordius*. Although metamerism is very distinctly expressed externally, it is not so well marked internally as in most forms, the enteron, for example, not being constricted by the dissepiments. The setæ are very regularly distributed over the body, and are either thin and sharp, or stronger and shorter; the two last metameres which are not so well differentiated as the rest, have, as a rule, no setæ. The enteric canal is a little longer than the body, and is for a great part ciliated; the ciliation resembling exactly that of *Æolosoma quaternarium*.

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* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 615–52 (2 pls.).

The blood-vascular system exhibits a very low degree of development, consisting of a dorsal and ventral trunk, which extends through the whole length of the animal; the former gives rise, in the first segment, to a short transverse trunk, from which arise two lateral trunks. The blood is yellow and non-corpusculated; the walls of the vessels are formed by a fine structureless membrane in which nuclei are imbedded. Distinct pulsations could not be detected, though there was a regular current. A structure, comparable to the solid cord of cells in the interior of the dorsal vessel, described by von Kennel in *Ctenodrilus pardalis*, is here also present; both these may be compared with the darkly-coloured organ found by Claparède in *Cirratulus*, *Terebella*, and others.

The head is made up of the cephalic lobes and oral segment, and is distinguished from the metameres which succeed it by its relatively greater length and the possession of the very characteristic proboscis, of the tentacle, and of the segmental organs. The cœlom, as in *C. pardalis*, extends into the cephalic lobes. The whole of the ventral surface of the head is ciliated, and these cilia serve to drive currents of food to the mouth of the worm. The author regards the head as essentially different from all the succeeding segments. The proboscis lies beneath the mouth, and consists of a solid, muscular, broad plate; it opens into a chamber common to it and the mouth and has apparently the function of a locomotor organ.

The resemblances to *Polygordius* which this new form exhibits are emphasized by the possession of a single tentacular organ, the fellow of which seems to have been lost in the course of time. It arises just below the proboscis, and is capable of doubling its length; owing to the possession of a special musculature, it can also become considerably diminished. It is distinguished from the tentacle of *Polygordius* by the absence of a diverticulum of the cœlom; it is marked externally by a ciliated groove, the cilia of which work towards the body; it appears to be not only a tactile organ, but also to bring food to the mouth. Individuals with two tentacles are not rarely seen.

Like *C. pardalis*, *C. monostylos* has only one pair of segmental organs, and these are placed in the head; they are coiled, finely granular tubes, and the cilia around the cœlomic orifice are very delicate. In the nervous system the new species considerably resembles the already-described species of the genus; the dorsal ganglion is placed in the cephalic lobes, and its central mass is dotted; the ganglionic cells are only indistinctly separated from the surrounding epithelial cells; the ventral cord is not provided with metamerically arranged ganglia, but forms a simple well-developed cord, which extends through the whole length of the body; in very thin sections indications of a fine median membrane were occasionally detected, but no peripheral nerves could be made out. The nervous system remains in the hypodermis. Cells of peculiar character, and apparently of mesodermal origin, are to be found floating in the cœlom.

The author next describes the processes of division, which seem to be of a much more primitive character than in *C. pardalis;* all individuals which consist of twenty or more segments are capable of division; there are no preliminary phenomena of gemmation, no zone of gemmation as in *C. pardalis*, but only a slight constriction of the integument, which gradually becomes more and more pronounced; the two daughter forms are at first without any head or anus respectively, and it is only some time after the constriction that these organs begin to be formed. They may give off fragments of one to three segments which have neither head nor anus, and are no longer capable of division, or pieces of five or six segments which may again divide and give rise to fragments similar to those already mentioned. Lastly, the daughter form with the primary head is capable, after the production of a secondary anus, of giving off the terminal portion, but it is not known whether the other half of the parent form is capable of a similar action. After discussing the phenomena of division which he has observed, and comparing them with what is known in other forms, the author passes to the affinities and systematic position of *Ctenodrilus.* He regards it as a "collective type" which stands near the point of union of the Oligochæta and Polychæta, but, as in the case of *Polygordius*, we can hardly, as yet, assign to it a definite and fixed position in the zoological system. While it has, no doubt, an alliance with the Polygordiidæ, it has some special affinities to the Oligochætous Naids, and other characters in which it as much resembles the Polychæta as the Oligochæta.

**Manyunkia speciosa.***—Under this barbarous name, J. Leidy describes a new fresh-water annelid closely allied to *Fabricia.* The tube is composed of very fine particles, cylindrical, sometimes feebly annulated. The tubes are formed separately, or a few together, and they measure from 2 to 4 lines in length, and 1/5 to 1/4 of a line in width. The mature worm is 3 to 4 mm. long, and 1/4 mm. in breadth, and consists of twelve segments, including the head; it is of a translucent olive-green colour; the head is surmounted by a pair of lateral "lophophores," which support the tentacles. The seventh segment is twice as long as any of the others, and has an abrupt expansion at the fore-part, which suggested the production of a head prior to the division of the worm; gemmation, however, has not been observed. The number of tentacles varies with the age of the worm, but there are generally eighteen on each "lophophore" in a mature specimen; they are ciliated, and in all respects bear a close resemblance to those of the Polyzoa; they have various functions, and may be as justly called tentacles as cirri. At their base are six or more brownish pigment-spots, which resemble but have not the constitution of eyes. The segments behind the head are provided with a fascicle of locomotive setæ, some of which are shorter than the rest; there are from four to ten in each fascicle. The setæ have the form of a long straight rod, with a blade which terminates in a long filament; some of the posterior segments have

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* Proc. Acad. Nat. Sci. Philad., 1883, pp. 204–12 (1 pl.); and see E. Potts, ibid., January 22, 1884.

also a fascicle of "podal hooks," which vary not only in corresponding segments of different individuals, but on either side of the segments of the same individual.

The intestinal canal is a simple median tube dilated in each segment; the mouth is unarmed, funnel-like, and capacious. There is a well-developed eye on the head at the side of the gullet, but there does not appear to be any trace of posterior terminal eyes, such as are found in *Fabricia*. The ova appear to be laid and hatched within the tube, so that the young are cared for by the parent till sufficiently developed to provide for themselves.

The paper concludes with some observations on the species of *Fabricia*, to which *M. speciosa* is most closely allied; the simple eyes were observed to vary in different individuals, and on the different sides of the same individual.

**Parasitic Nematode of the Common Onion.***—J. Chatin describes an apparently new species of *Tylenchus*, which infests the bulb of the common onion. In its larval stage, it penetrates into and disorganizes the central tissue, converting the fibro-vascular bundles into a brownish pultaceous mass. Growth goes on and the sexual organs become matured; the fertilized ova give rise to claviform larvæ, which are able to escape owing to the destruction of the bulb; these, if the ground is moist enough, wander about on it, but if it is dry they remain quiescent until damp weather comes. They then enter a healthy onion, and the cycle recommences. If the nematoid enters an animal host it passes out with the fæces, and does not undergo in its intestine any further development, nor does it become encysted. On the whole it has a close resemblance to the *Anguillula* of wheat, but it is not so capable of resisting desiccation. The best remedy against it is to burn all the affected onions.

**New Myzostomata.**†—L. Graff gives an account of the new species of Myzostomata which were collected by Dr. P. H. Carpenter off the Crinoids of the 'Hassler' and 'Blake' expeditions; of the 22 species, 21 are new; of those 14 are peculiar to the American collections, while the others have been found elsewhere also. Postponing all details to his 'Challenger' Report, the author here merely describes the species, which may be divided into two groups: the members of the first of these are hermaphrodite, ectoparasitic, and produce no deformity on their host; all but one species are provided with suckers: in the second group the animals have the sexes separate, and live by pairs in cysts of their hosts; they have no suckers. The entoparasitic forms produce various abnormalities, merely widening the pinnulæ, or at the same time converting them into a spiral coil, or they produce pyriform outgrowths of the pinnules, or various kinds of cavities in the arms. Cysts are sometimes formed by calcareous deposits, which are found on the arms as well as on the disk.

**Bucephalus and Gasterostomum.**‡—H. E. Ziegler gives an account of these two parasites. After an historical review and an account of the external form, the description of the integument is entered upon, and it is pointed out that if we look upon the tegumentary layer of the Trematodes as having the same structure as that ordinarily described as obtaining in the Cestoda, we must regard the parenchymatous-like cellular layer which succeeds the muscular as being of an epithelial nature, for its fine processes pass out between the muscular fibres, fuse above it, and secrete the "cuticle"; if this view of the nature of the parts be the correct one, it is clear that all that has been said about the presence of nuclei in the cuticle must rest on erroneous observations.

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* Comptes Rendus, xcvii. (1883) pp. 1503–5.

† Bull. Mus. Comp. Zool., xi. (1883) pp. 125–33.

‡ Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 537–71. (2 pls.).

The movement of the body of *Gasterostomum* is described as being effected in the following fashion: the body is narrowed and elongated by the contraction of the circular muscles, the head is then protruded, the sucker widens and deepens, and at the same time the muscles in the upper lip of the sucker, aided by others, bring about a flattening of the anterior surface of the body and the formation of a dorsal ridge by the aid of which the body fixes itself; by the contraction of the longitudinal muscles the body is drawn after the sucker.

In both *Bucephalus* and *Gasterostomum* it was impossible to detect the limits of the cells of the parenchyma, but in the latter they were clearly seen to be of two forms; some elongated or branched, which were of a connective or muscular nature, and others rounded and less coloured, which seemed to take a part in the osmotic distribution of the nutrient material. The nervous system is briefly described.

In *Bucephalus* we find at the last third of the body a small tubular depression of the integument, which leads into the pharynx; this can suck in fluid by enlarging and then undergoing a peristaltic contraction. The œsophagus is formed by a homogeneous layer. In the intestine there are large yellowish cells; if the animal has been for a long time in water the intestine is found to have fluid contents in which float greenish yellow spherical concretions. The intestine may seem to be produced into two processes, which appear to owe their origin to the compression, on the ventral wall of the body, of the ventral sucker.

The arrangement of the muscles of the pharynx is the same in *Bucephalus* as in *Gasterostomum*; in the latter the stomach has an oval contour, while the intestine has in form, position, and structure a considerable resemblance to that of the Rhabdocœlida. The author is the first who has detected the presence of a distinct œsophagus in *Gasterostomum*.

The quantity of water which passes through the water-vascular system of *Bucephalus* is so great that it may well be supposed to have a respiratory as well as an excretory function.

In *Bucephalus*, cells with nuclei which colour intensely, are to be seen in the last fourth of the body; these are probably converted into the penial sheath; somewhat more anteriorly and dorsally there are several groups of closely appressed cells, the nuclei of which are very intensely coloured; these are supposed to be the indifferent rudiments of the reproductory elements. The generative apparatus of *Gasterostomum* is described, and a hypothetical account of the mode of action of the copulatory organ is given. By the aetion of the longitudinal musculature of the penial sheath a part of the ductus ejaculatorius is evaginated, until at last the cirrus projects from the genital sinus; this is probably approximated to the orifice of the genital canal. Self-impregnation through the uterus would appear to be possible.

After an account of the remarkable "tail" of *Bucephalus*, the author passes to the life-history of the two forms. The embryo which, by unknown means, reaches the *Anodonta* or *Unio*, becomes there several centimetres long, and gives off lateral branches; the body-wall is thin, and comparable to the parenchyma of the body; within are found *Bucephali* of various stages of development, and arranged in groups. The *Bucephali* escape from the mussel by the anal siphon. After swimming about for some hours, the cercariæ sink to the bottom, and, to undergo further development, they must now enter a suitable host; in the neighbourhood of Strassburg this is ordinarily *Leuciscus erythrophthalmus* (the Rudd); the cysts lie in the connective tissue under the skin, and the containing capsule appears to be very thin and elastic. During the period of encapsulation the animal grows, its water-bladder becomes swollen out and filled with highly refractive spherules, which are probably the final products of metabolism, the stomach becomes relatively smaller, and the anterior sucker and generative organs are developed; the spines become larger and more distinct. If the host fish is eaten by another fish the encysted animals are set free and become sexually mature in the intestine of their new host; but experiments are still wanting to complete this part of the life-history of these parasites.

**Development of Dendrocœlum lacteum.***—J. Jijima finds this Planarian to be sexually mature once only during its life; the ova contain an immense quantity of yolk-cells, and 24 to 42 embryos are to be found in one cocoon, whereas Metschnikoff only found 4 to 6 in *Planaria polychroa*. The ova appear to remain for a month or six weeks in their cocoon; this much longer period, as compared with the ten days of *P. polychroa*, is thought to be due as much to differences in temperature as to those of species. The segmentation is total; the solid morula has a peripheral layer of cells which seemed to be fused together, and an internal mass in which the form of the blastomeres is still recognizable; as these latter multiply the bounding layer increases in thickness, while the free nuclei become more abundant; in fact, there appears to be a process of proliferation. When the embryo is 0·2 mm. in diameter the ectoderm may be seen to be formed by a certain number of flattened cells, and the yolk-cells are then separated from the embryo. The author agrees generally with Metschnikoff in his account of the formation of the pharynx. From the fifteenth to the eighteenth day the yolk-cells inclosed in the cocoon are absorbed by the embryo, which may now be one millimetre in diameter; the pharynx undergoes degeneration and its place is taken by the cavity of the proboscis; a short time before it leaves the cocoon an oral orifice is developed. Like Metschnikoff, Jijima could not satisfy himself as to the ectodermal origin of the nervous system. The enteric epithelium is formed of cells which are filled with a finely granular protoplasm, or small masses of fat-drops. These appear to owe their origin to the breaking-up of the yolk-cells, and it is in this region only that the cells have fatty contents. The author cannot agree with his predecessor in thinking that the yolk-cells are transformed into the epithelial cells of the intestine; he finds, rather, that these yolk-cells lose their individuality and become transformed into irregular masses, while no trace is left of their nuclei.

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* Zool. Anzeig., vi. (1883) pp. 605–10. Also Bull. Sci. Dép. Nord, vi. (1883) pp. 100–5.

**Rotatoria of Giessen.***—K. Eckstein commences with a review of the genera and an account of the fifty species of Rotatoria found in the neighbourhood of Giessen.

Treating of *Floscularia appendiculata* he discusses the question whether the long cilia are stiff and immobile, or whether they form currents which carry the food to the mouth, as in other Rotifers. Although never able to observe that the cilia act as described by Ehrenberg, he has been able to convince himself that they are capable of voluntary movements and react to external stimuli. The long, thin, finger-like process which lies among them has probably a sensory function. No distinct ganglion could be detected, but sensory organs were obviously represented by a process on the dorsal surface, lying just behind the wheel-organ, which carried a tuft of setæ. Two red eye-spots were seen at the margin of the orifice, when the animal was in a contracted condition. In the young the wheel-organ consists of a circlet of not very long cilia placed on the edge of the oral funnel. In *Ptygura melicerta* the foot is provided with large glands, by the secretion of which the animal is able to attach itself to water-plants; its blood-corpuscles are of a comparatively large size. *Philodina roseola* is to be distinguished from *P. citrina* by the regular distribution of its coloration, which is not absent from the first and last joints as in the other. In most of his specimens of *Rotifer vulgaris* Eckstein was able to recognize a lens in the eye; in many cases he found that one or both eyes were divided into two or three, or even into ten or twelve, red corpuscles. In addition to the cephalic ganglion there were detected a large spindle-shaped cell, lying on either side of the rectum, and exactly comparable to the nerve-cells found by Leydig in *Lacinularia socialis*. In *Notommata aurita* the ganglion consists of two layers, of which the inner is homogeneous and the outer granular. The mode of locomotion of *N. lacinulata* is described, as are the voracious habits of *Eosphora lacinulata*, the differential characters of which, as compared with *Triophthalmus dorsalis* are pointed out, and it is shown that the latter is not the young of the former. The tail of *Scaridium longicaudatum* is of great assistance in the execution of rapid movements. *Diurella rattulus* swims about with its dorsal surface downwards and executes with it movements to the right and left, while the head and tail form fixed points.

In *Monostyla lunaris* fixed points are obtained by the better development of the carapace in certain regions. A new genus *Distyla* is defined as having the carapace depressed, open anteriorly and closed behind; the foot is one-jointed and has two long "toes." The carapace is ridged in the region of the foot, the wheel-organ is feebly developed. *D. gissensis* and *D. ludwigii* are the new species.

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* Zeitschr. f. Wiss. Zool., xxxix. (1883) pp. 343–443 (6 pls.).

In *Euchlanis dilatata* the central organ of the nervous system consists of a number of lobes, and carries one large red eye; it is connected by fine filaments with a pit of tactile function. At the hinder end of the body there are two organs, which appear to be the chief ganglia of the nervous system, for they are long and spindle-shaped, and pass anteriorly and posteriorly into fine filaments. *Squamella bractea* has four eyes, of which the anterior are somewhat larger than the hinder pair, and distinctly contain a refractive body. Behind there is a small tactile tube, which is beset at its end with setæ. In *Pterodina* the foot has not, as in other Rotifers, the function of an attaching organ, but serves as the hind-gut (?); it can be contracted, but not retracted.

In the second half of this essay Eckstein enters into a general biological, anatomical, and developmental history of the Rotatoria. He finds that there is no true segmentation of the body, and that the jointing of the integument is dependent on the firmness of this layer. The apparent, or rather externally radial form of some (*Stephanoceros*, *Floscularia*) is due to their fixed mode of life.

A short comparative account of the wheel-organ is given. The colourless muscles are (1) quite homogeneous, each being formed of a single fine fibre, or (2) have in their centre a chain-of-pearl-like band of clear nuclei, or (3) they are distinctly transversely striated. Where, as in *Scaridium*, there is great muscular activity, all the muscles of the body are striated. There appears to be still much to learn with regard to the nervous system, Leydig, for example, refusing to recognize a central organ in *Lacinularia*, and describing, as chief ganglia, the four nucleated spindle-shaped swellings which lie by the mastax and the rectum. The eye-spots may lie on, behind, or in front of the central ganglion; a convex transparent lens is present in some, though not in all; the eyes may be paired or unpaired, or two may be fused into one. Other red spots, without refractive bodies connected with them, are sometimes found on the wheel-organ. The organ taken by Huxley for an otocyst is rather the calcareous pouch, which is an appendage to the ganglion, and lies either in front of or behind it. It has a spherical or reniform shape, and consists in some cases of irregular aggregations of calcareous granules; it is often continued forwards as a fine granular cord, or as a broad sac-like organ, attached at one end, and by the other projecting freely into the cœlom; further observations are necessary to determine the function of this apparatus.

In all Rotatoria (*pace* Huxley) the anus lies on the neural side; the excretory system has a contractile vesicle formed of a fine structureless membrane, bounded by a system of delicate and almost invisible muscular fibres, which suddenly contract its lumen; the vesicle enlarges again slowly by the elasticity of its walls, or by the pressure of the inflowing fluid. The canal on either side may be followed up to the neighbourhood of the wheel-organ; the transverse canal described by Huxley in the cephalic region of *Lacinularia* has not been detected by any subsequent observer. The author describes the ciliated infundibula as having their thinner end attached to the canal, and their broader one hanging freely into the cœlom. From the upper end a broad cilium projects into the lumen of the funnel, and moves either rapidly or slowly; Eckstein does not think that the swellings are funnels—that is, he does not regard them as open at their free end, but as being completely closed by a hemispherical operculum, to the middle of which the long cilium is attached. Below this operculum there is an orifice, which in the smaller species is small and round, but is generally large and oval; at this hole there commences a very short tube, which leads at once into the lateral canal. By the action of the cilium the waste products of the body are forced into this canal, and so make their way by the contractile vesicle to the exterior. The differences from this typical arrangement which are found in various Rotifers are pointed out, and the resemblances to what Fraipont has found in the excretory organs of the Trematoda are indicated.

The club-shaped pedal organs are next considered, and the tendon by which they are kept in place alluded to; these organs are glands with finely granular contents, and in their middle a line of greater transparency may often be detected, which is probably the optical expression of a groove, in which the secretion of the glands is collected, and by which it is conveyed to the exterior. Sometimes the secretion appears to serve as a means by which the foot may be glued down, in other cases it gives rise to a fine filament; the function, however, of this secretion is not so much to fix the animal down for a time as to attach it until the third joint of the foot is firmly affixed, when the first and second joints being retracted, a vacuum is formed. Respiration appears to be effected through the skin, and this appears to be the function of the pores of *Brachionus plicatilis*. There is no circulatory system developed. The author is unable to explain the office of the "renal organs" discovered by Leydig in the young of *Floscularia*, *Stephanoceros*, &c. (Cohn has already objected to Leydig's view of the renal function of the organ in question); nor can he say anything as to the organ found near the intestine in *Squamella*, or the body which lies dorsally to the intestine, with which it is connected, in all species of the genus.

Eckstein next discusses the well-known phenomena of the dimorphism of the sexes, and the structure and characters of the reproductive organs; in the Philodineidæ the ovum passes through the earlier stages of development in the uterus, but, owing to the movements of the body, this apparently useful arrangement is of no advantage to the student. Like some later observers, the author would call the winter ova lasting ova, as they are by no means developed in the winter season only, but are rendered safer by the possession of a firm shell. As in other divisions of the animal kingdom, parasitic habit has its effect on the organization of the parasitic form, such as *Seison*, or *Albertia*.

The Rotatoria are divided (1) into those in which the female always has, and those in which it has not an anal orifice to the intestine; (2) the former into (α) those that are permanently fixed, and (β) those that are free-living; (3) the former of these into (i.) separate, (ii.) colonial forms; the latter into those in which (i.) the body is rounded and apparently unsegmented, and (ii.) the body is saccular or flattened with apparent segments. Into the further details of this somewhat artificial classification we have not the space to follow the author.

After reviewing the opinions of previous writers as to the systematic position of the Rotatoria, Eckstein points out that their direct alliance with the Annelida is opposed by the early appearance of segmentation in those forms; the view of Korschelt and Metschnikoff that the Rotatoria are allied to the Turbellaria by *Dinophilus* is affected by Graff's belief that that genus is a true Rotifer. The author would associate with the Rotifera the Gastrotricha, but, in truth, their systematic place is even more indefinite than that of the Rotifera themselves.

**Rotifer within an Acanthocystis.***—Dr. A. C. Stokes' account of an observation of a rotifer living within the rhizopod *Acanthocystis chætophora* is not perhaps written with any severity of scientific style, but it is evident that any abstract we could give of it would fail to convey a correct idea of the original. It is also the first instance of which we are aware, of astronomical time being applied to microscopical observations.

"Recently one of these spinous creatures [*Acanthocystis*] appeared under my Microscope. It seemed to be alive and well, but within it near the armoured surface, was a semi-transparent moving something that was too active to have a right there. As the motions of this foreign body became more impulsive, it turned completely over and showed itself to be one of the rotifers. In size it equalled not more than one-third the *Acanthocystis*' diameter, but dwarfish stature was amply compensated by nimbleness.

With a leap, prodigious for so small a creature, the rotifer dashed against the wall and hurled the rhizopod down the field, while the silicious spines snapped and flew. If the scene was exciting to the spectator, what must it have been to the *Acanthocystis*, with that jumping Jonah leaping among its vitals? It was no joke to either party. A struggle for life was going on under my very eyes. The rhizopod, with every particle of its jelly-mass surrounding the rotifer possessing digestive power, seemed calm, perhaps with the calmness of despair, but the rotifer—oh how she plunged! Not a moment did she rest, not a muscle did she leave unused, not a manœuvre untried. The situation appeared a bad one for that rotifer, since she bade fair to be digested. She stretched herself and forced out the spinous armour until it seemed on the point of rupture; the *Acanthocystis* simply flattened the opposite side and waited, digesting. The rotifer leaped, she turned, she pushed with her two sharp toes against the wall; the rhizopod rolled over the field, the spines were loosened and fell off, yet that rotifer remained in the corner where she first appeared, pressed down by the *Acanthocystis'* body-mass, although her efforts were continually nothing less than frantic. For six hours the struggle lasted; from 14 to 20 o'clock the microscopic creatures were under uninterrupted observation. Finally, after a short rest on the rotifer's part, there occurred one of the most amusing exhibitions of intelligence in these lowly organisms that I have ever seen. It was indeed a most masterly piece of strategy. *The rotifer began to eat!* Protoplasmic jelly, chlorophyll-corpuscles, half-digested food-particles, everything the *Acanthocystis* contained streamed down into the rotifer's transparent stomach. With short intervals, which she improved by butting against the wall, she ate until she arrived at the central nucleus, when, apparently perceiving that her object was accomplished, she stopped, and then—it really did seem as if she was celebrating her victory—then she laid an egg!

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* The Microscope, iv. (1884) pp. 33-5.

The rhizopod once dead and half empty, the brave rotifer selected the spot at which she intended to leave, and left. It is a curious fact that, having chosen the place for exit, she continued to beat against that point only, until the basal plates were forced aside, and she was free. Circling once or twice around the dead *Acanthocystis* she darted from the field, followed by applause, and a few remarks of approval from the spectator.

By 24 o'clock the ovum that had been extruded in my presence as well as in prison, which I had seen rolling down the half-empty *Acanthocystis'* sac, had accomplished a part of its internal changes, but an awkward movement displaced the cover-glass, and ruined all.

Did that unhappy rhizopod in an absent-minded moment take in an egg, and did that egg eventually take in the rhizopod? Was the development of the egg so far advanced that the rotifer was hatched before it could be digested?"

## Cœlenterata.

**New Alcyonarians, Gorgonids, and Pennatulids of the Norwegian Seas.*** —J. Koren and D. C. Danielssen have published another of their beautifully illustrated works on the fauna of the Northern Seas; they describe a new genus *Duva*, in which they place three new species, and the *Gorgonia florida* of J. Rathke, which is not the same form as the *Gersemia florida* of Marenzeller. The other new genus is *Göndul*, for which it is necessary to establish a new family of Pennatulids—*Göndulеæ*—characterized as having the rachis fixed, with developed bilateral pinnules, and furnished with long calcareous spicules. The stalk in *Göndul* has a canal in its centre, which is divided by four valves into as many longitudinal canals. The genus *Cladiscus* is removed from the family Protocaulidæ, where it was placed by Kölliker, to the Protoptolidæ, in consequence of the presence of well-developed "cells." A number of new species are described, but, unfortunately, only the diagnoses are given in English, the full details being described in Norwegian. There is, however, a brief description of the plates in English.

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* 4to, Bergen, 1883, xvi. and 38 pp. (13 pls.).

**Origin of Coral Reefs.**[*]—Prof. A. Geikie sums up a considerable amount of evidence which has accumulated since Charles Darwin's theory on this subject was put forth, tending to show that the theory (essentially that of growth of coral in connection with subsidence of the sea bottom) is by no means universally applicable. Semper and Rein supposed that in some cases raised masses of sand or deep-water corals are formed which afford resting places for surface-growing corals; the form of the islands, Semper held, is caused by the death of the inner parts of the colonies of corals, and by the action of the tides. Mr. J. Murray, from observations made on the 'Challenger,' considers that volcanic cones, such as form most oceanic islands, tend to be reduced to submerged banks by the action of the waves; also that the raising of the sea bottom to such a height as to favour the growth of corals, is due to the unusually rapid accumulation near the shore of calcareous débris derived from dead pelagic organisms. These are so abundant as probably to represent upwards of 16 tons of carbonate of lime in suspension in the uppermost 100 fathoms of every square mile of the ocean. In the deepest water these appear to be dissolved before reaching the bottom, but they accumulate on shallow bottoms, and thus furnish foothold for sponges, various Cœlenterates, &c., which in return die and bring up the bottom to the level of reef coral growth. This, taking place on a submerged bank, would produce the atoll form of island, which would tend to widen by death inside, and by the consequent solution of the dead coral by the carbonic acid of the sea-water. Special cases, such as elongate chains of atolls, e. g. the Maldives, or submerged banks, as the Chagos, fall in with the theory. Barrier reefs are similarly explained as due primarily to growth upon accumulations of débris around land.

**Porpitidæ and Velellidæ.**[†]—We have here a notice of the work of A. Agassiz on these little known Hydrozoa. *Velella mutica*, of the coast of Florida, is much larger than the Mediterranean *V. spirans*, and not unfrequently reaches 4 in. in length. It is exceedingly common in Key West Harbour, which it visits in large schools. Feeding is chiefly effected by the large central polypite of the system, and this, together with the smaller polypites, is connected at its base with the general vascular system, through which, as in the polypites, the fluid is rapidly propelled by the lining cilia. At the base of the polypite are the medusoid buds, and these, it is interesting to note, early become provided with the yellow cells which are characteristic of the free Medusæ. The young present a striking resemblance to certain Tubularian Medusæ, being provided with a row of lasso-cells which extend from the base of the tentacles to the abactinal pole.

The Floridan species of *Porpita* (*P. linneana*) is, similarly, larger than the Mediterranean *P. mediterranea*; unlike *Velella* it has a considerable power of control over its own movements, and is by no means so much at the mercy of the winds or waves. If upset in the water it returns to its original position by bringing its tentacles together over the disk, and throwing up the free edge of the mantle in a given direction, then expanding the tentacles of one side far over in the opposite direction beyond the central part of the disk; thus, it readily changes the centre of gravity and tilts the overturned disk back again. Medusæ are to be found at all stages of development.

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[*] Nature, xxix. (1883) pp. 107–10.

[†] Mem. Mus. Comp. Zool., 1883. See Nature, xxix. (1884) pp. 262–3.

Prof. Agassiz suggests that *Porpita* is allied to the Hydrocorallinæ, and he bases this suggestion on the possession of the so-called white plate, the peculiar structure of which reminds him of the corallum of *Sporadopora*, *Allopora*, and *Millepora;* there are large pits, and the whole mass is spongy from being riddled with passages and openings; but there are not, of course, the regular horizontal floors which are seen in *Millepora.*

The value of the paper is greatly increased by the twelve plates, two of which give coloured full-sized representations of the two species described.

### Porifera.

**Physiology of Gemmules of Spongillidæ.***—To this subject, which is now exciting considerable interest, Dr. W. Marshall contributes some arguments and observations which should be compared with those given by Dr. Vejdovsky (see below). The wall of the gemmules of *Spongilla nitens* (as of *S. carteri*) consists of a system of closed spaces or cells. In *S. nitens* they form six-sided columns with their long axes tangential to the central mass; they diminish in size towards the interior of the gemmule; the outer cells are hollow and in the dry state filled with air, the innermost are solid. These cells are not histological cells, but of cuticular character; their walls are strongly refractive, and resist combustion stubbornly; fluoric acid destroys their refractive power and brittleness, so that it appears not improbable that they contain a large proportion of silica; the inner layer of spined spicules is attached to this cellular layer with more firmness than to the subjacent horny layer. *S. nitens* has an air-space, formed by the chitinous layer, as in *S. carteri*, which enables the dry gemmules to float for from 8 to 10 days in water. The elaborate envelopes which cover the abundant starch which accompanies the germinal matter provide in the most satisfactory manner for the protection and welfare of this material. Various arguments are advanced in favour of the aerostatic character of the cellular coat of the gemmule, viz. the smallness and, owing to the great relative development of this layer, the lightness of this body in *S. nitens.* In the districts where the sponge occurs it must often be left dry by evaporation and the gemmules subsequently set free may be carried long distances by the wind, and eventually germinate if they meet with fresh water again. Thus, of Ehrenberg's figures of organisms found in trade-wind dust, about 24 per cent. refer to sponges, and of these fragments about 16 per cent. (4 per cent. of all the organic remains) are whole or fragmentary amphidisks of *Spongillidæ*; the absence of entire gemmules is explained by the distance which Ehrenberg's dust had travelled, viz. to Europe from (probably) North-west Africa.

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* Zool. Anzeig., vi. (1883) pp. 630–4, 648–52.

By experimenting directly on gemmules of *Spongilla lacustris* and *nitens*, by drying them for 8 days, piling 50 of each species together into one heap on a smooth plate, and blowing at them with a bellows, it was found as the result of this operation, repeated six times, that the gemmules of *S. nitens* were scattered to a greater distance than those of *lacustris*, viz. 75 per cent. beyond a radius of 5 centimetres, as against the 64 per cent. of those of the other species which stayed within this radius.

The gemmule of the South American species *Parmula Brownii* has a very compact spicular shell, the spicules show a tendency to radiate from points at which the capsule is in contact with the true envelope of the gemmule: the latter envelope is covered with conical eminences which fit loosely against the outer capsule while dry, but come closely against it after soaking for some time in warm water—probably showing that it is a special arrangement to allow of the expansion of the germ, the outer capsule having no opening. The shield-like spicules overlap and cover all the surface of the inner envelope except the eminences just described. The outer capsule is usually firmly united to the surrounding skeleton. The sponge is known to affect, as its rooting places, stones which are alternately wetted and left dry. Thus, the close connection of the skeleton with the capsule secures it from being detached when dried, and the overlapping arrangement of the shield-like spicules prevents excessive collapse of the tender underlying envelope.

The heaviness of the gemmules of *Spongilla lacustris*, and their projecting spicules (like the hooks of Polyzoan statoblasts) tend to anchor them and prevent undue rapidity of transportation by currents. The gemmules of the allies of *S. fluviatilis* are heavier than those of *lacustris* and allies, and hence are less mobile and better adapted to rapid streams. The three layers of amphidisks in the gemmule of *Meyenia mirabilis* Retzer (a recently described species) are perhaps an adaptation to very rapid waters.

Marshall thinks it not inconceivable that external circumstances (e. g. long sojourn in still water) might transmute *Spongillæ* (*Euspongilla*) into *Meyeniæ*, and *vice versâ*; of the present occurrence of these changes perhaps *Euspongilla jordanensis* var. *druliæformis* Vejdovsky affords an example in the transitional characters of its gemmule spicules.

**European Fresh-water Sponges.***—Dr. F. Vejdovsky supplements his former study of this subject† by some additional observations: firstly he establishes the new species *Ephydatia amphizona* for the form previously described by him as *Eph. Mülleri forma B.*, reserving

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* Abh. Böhm. Gesell. Wiss., 1883. See Ann. and Mag. Nat. Hist., xiii. (1884) pp. 96-8 (1 pl.).

† See this Journal, iii. (1883) p. 858.

Lieberkühn's name *Eph. Mülleri* for his own var. *astrodiscus*. The Bohemian *Eph. fluviatilis* is identical with the British *Spongilla fluviatilis*. Turning to the different layers of the wall of the gemmules, he finds the new species to be distinguished by possessing two concentric layers of birotulate spicules; of these the outer layer project from the external parenchymatous layer by their shafts and outer disks, the inner disks lying in the subjacent parenchyma; a thick parenchymatous layer is now found (as we pass inwards), containing on its inner aspect the internal layer of birotulate spicules, whose inner disks are in apposition with the brown chitinous membrane, which immediately incloses the germinal corpuscles. *Trochospongilla erinaceus*, from the Elbe, shows the following characters in its gemmules. The layer which represents the parenchymatous layer of other *Spongillidæ* is modified to form a mass of five- to six-sided long prismatic columns, whose long axes are perpendicular to the surface of the gemmule; they are divided transversely into air chambers; the walls are firm and glistening, and probably consist of chitin. Beneath this layer come the amphidisks, lying on the very stout and laminate chitinous membrane. The parenchymatous layer, as here modified, probably acts as an aerostatic apparatus for the transportation of the gemmule, and corresponds exactly to the natatory rings of the statoblasts of many fresh-water Polyzoa. Dr. Vejdovsky has hitherto been unable to discover a similar arrangement in the nearly allied North American *Meyenia Leidii*.

**New Genus of Sponges.**[*]—G. C. J. Vosmaer gives an account of *Velinea gracilis*, a new genus or species of sponge found in the Bay of Naples. A study of this form has convinced him that the water which enters a sponge, having once passed a ciliated chamber, does not enter another, but is carried away. The skeleton is very remarkable; it consists of a rather regular network of horny fibres, lying in three planes, and the six fibres forming the longitudinal, concentric, and radial systems meet at approximately right angles, so that the contained meshes are nearly square. The skeleton is, speaking generally, solid and hexactinellid.

The author does not feel himself able to speak definitely as to the characters of the epithelial cells, as he was not successful in detecting their limits; a similar kind of epithelial cell is found in all the afferent and efferent canals. The collar-cells are remarkable for their small size.

In discussing the systematic position of *Velinea*, the author enters in detail into the characters of the allied families Aplysinidæ, Aplysillidæ, Spongidæ, and Hircinidæ; placing it in the family of the Spongelidæ. Useful differential characters are given for these five families.

## Protozoa.

**Bütschli's 'Protozoa.'**—Parts 20–25 of this work have been published with plates xxxix.–l. They deal with the Mastigophora, Diesing's name being applied to what are now more often called the Flagellata.

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[*] MT. Zool. Stat. Neapel, iv. (1883) 437–47 (2 pls.).

The organisms placed in this division are characterized by the fact that the motile stage forms the chief period of their lives; and this stage is not only that which is relatively the longest, but that also in which the organism best exhibits its nutrient and growing activity. The objection that it is often impossible to separate the Mastigophora from certain of the simpler Sarcodina, as well as from certain simpler vegetable organisms, such as the Protococcoid Algæ, the Myxomycetes, and the Chytrideæ is to be met by the reflection that all these forms have a common origin.

The Mastigophora may be divided into four subdivisions or orders: (1) Flagellata, or forms which have flagella without either superadded cilia or "collars"; this is the largest and most varied group. (2) Choano-flagellata have a collar at the base of the single flagellum, which calls to mind the collared or so-called endodermal cells of sponges. (3) Cystoflagellata have a retiform structure of their protoplasm, not unlike that which is seen in plants; and they are, further, characterized by their peculiar form, and, possibly also, by their reproductive phenomena. The (4) Cilio-flagellata have cilia as well as flagella.

An interesting historical review is followed by the citation of 206 separate works or essays. The Flagellata are divided into the (1) Monadina, which are of simple structure and have one flagellum, or two small ones; there is no special oral orifice, or it is simple and is not continued into a well-developed pharynx. (2) Euglenoidina: these are better developed forms of some considerable size, ordinarily provided with one, but in some cases with a second small or large flagellum. The so-called mouth at the base of the flagellum is constantly present, and often leads into a distinct pharynx. (3) Isomastigopoda, with two or, more rarely, four or five subequal flagella; mouth rarely developed, and nutrition very ordinarily effected as in plants. (4) The Heteromastigopoda have two flagella at the anterior end, which are equal or unequal in size, and are respectively directed forwards and backwards.

The structural and developmental characteristics are entered on, and treated of in detail, but the arrangement of the genera and species is not yet begun.

**New Infusoria.**—D. S. Kellicott describes* a *Cothurnia*, a parasite of the crayfish in America, to which he gives the specific name of *variabilis*, as he finds it to vary so much. The lorica is about twice longer than broad. Seen from the side, it is strongly ventricose, and uniformly convex posteriorly. The neck is narrow, its width being less than half that of the carapace; the laterally compressed orifice is set very obliquely, sometimes quite vertically, with the upper edge produced into a cusp, and with a tooth-like angle in the middle of either margin; the aperture is sometimes awry, turning the cusp to one side of the axis of the shell. The peduncle is short, not exceeding, as a rule, one-fourth the length of the lorica;

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* Bull. Buffalo Naturalists' Field Club, i. (1883) pp. 112–4 (5 figs.). Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 105–7 (5 figs.).

it is often less, and the shell apparently sessile. The animal is attached to the bottom of the sheath; the peristome is narrow and is protruded only a short distance beyond the edge of the aperture. The contents of the zooid's body are finely granular; the nucleus of the usual bandlike pattern. The animal is very timid, and very rarely ventures beyond its shield while under observation.

The same author also describes* *Epistylis Niagaræ* n. sp., which occurs on the crayfish of the Niagara, and probably on other convenient supports, although not yet found elsewhere. It fastens upon the antennæ and exoskeleton, forming whitish, mucilaginous patches. The pedicle branches dichotomously, is smooth, attains 1/10 of an inch in length, and bears many zooids. So far the characters are closely those of *E. plicatilis* or *E. Anastatica*, both abundant in the same river. The zooids are elongate, more than three times as long as broad, slightly gibbous, much attenuated at the lower extremity. The body is constricted below the peristome border, which is thickened or collar-like. The ciliary disk is continued above the peristome as a prominent boss-like granular body. The inclosure is fine granular, the cuticle smooth. The nucleus is flat, twisted, and placed transversely at the upper third of the body. When contracted the ovoid bodies have a snout-like projection which is strongly striate longitudinally. Length of body fully expanded ·0064 in.

Dr. A. C. Stokes describes† several apparently new infusoria from putrid waters, *Heteromita putrina* and *Tillina saprophila* from an infusion made by placing the tail of a dead rat in river water, and *T. inflata* from an infusion of the outer layers of the bulb of a Chinese *Narcissus*.

Dr. A. C. Stokes also describes‡ a *Pyxicola* which he believes to be new, and names provisionally *P. constricta*. He has also found§ *Salpingœca urceolata* S.K. in fresh water, or at least a fresh-water variety of it.

J. Künstler describes‖ a fifth species of *Nyctotherus*, *N. Duboisii*, which inhabits the intestine of the larva of *Oryctes nasicornis*.

**Reproduction in Amphileptus fasciola.**¶—Dr. A. S. Parker believes he has observed a method of reproduction not hitherto described in the Infusoria. His attention was attracted by a peculiar oscillating movement, the *Amphileptus* rocking from side to side, the animal remaining stationary, although its cilia were in active motion. In other respects the animal appeared normal, no changes being observed in its nucleus, protoplasmic contents, or contractile vesicle. Shortly afterwards he found that the elongated extremity was breaking up into small masses of protoplasm; these gradually separated from the parent body, and each of them exhibited distinct amœboid movements. Although the cilia seemed to break off with the small masses, he could not detect any signs of their presence after separation. For about five minutes small protoplasmic masses, exhibiting distinct and independent amœboid movements, continued to be shed.

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* Bull. Buffalo Naturalists' Field Club, i. (1883) pp. 115–6 (1 fig.). Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 110–1 (1 fig.).

† Amer. Natural., xviii. (1884) pp. 133–40 (5 figs.).

‡ Amer. Mon. Micr. Journ., v. (1884) pp. 24–5 (1 fig.).

§ Ibid., pp. 25–6 (2 figs.).

‖ Journ. de Micrŏgr., viii. (1884) pp. 86–92 (1 fig.).

¶ Proc. Acad. Nat. Sci. Philad., 1883, pp. 313–4.

The rocking movement still continued, but now commenced to show signs of being converted into a movement of rotation. Finally, a rotary motion was established, and the animal commenced to change its position. At the same time was noticed a distinct elongation occurring at the end where the changes described above had taken place, a rounded projection appearing, which gradually elongated, until finally, in the course of about two hours, the individual had assumed its original shape and activity, although apparently somewhat diminished in bulk. Cilia covered the new growth, but they did not seem to be a new formation, but were produced by a simple elongation of the ectosarc, this being carried forward by the growing endosarc. As regards the protoplasmic masses that were shed or discharged, he observed them for about four hours, at which time they were still active, and the parent mass still in active motion. On the following day he was unable to detect them, and as to their subsequent history knows nothing.

To characterize the phenomena as described above, the term "Reproduction by Partial Dissociation" is proposed. Reproduction by fission, gemmation, conjugation, and encystation have all been observed in the ciliated infusoria; and some of the older writers, such as Ehrenberg and others, have described a mode of increase, in which the substance of the body breaks up into a number of fragments, each of which is capable of becoming a distinct individual. This process they called diffluence, but Stein and more recent observers have denied the existence of this process, claiming that it was merely a form of increase from encysted forms. The phenomena, as exhibited by *Amphileptus fasciola*, seem to be quite different from those described as occurring in diffluence, and it certainly was not a case of encystation. Dr. Parker being unable to find any account of reproduction in the Infusoria resembling that described, places the facts on record, in order that the attention of other observers may be directed towards the verification of the phenomena and views expressed above.

**Orders of the Radiolaria.***—E. Häckel reports that he has been able to add considerably to the two thousand new species of Radiolaria which, some time since, he was able to announce that he had detected "among the inconceivably rich Radiolarian collection of the 'Challenger' collection." Increase of knowledge has led to a reduction of the proposed seven orders to four, and the complicated system is now "much more comprehensible"; it now seems to be certain that the distinction between the monozoic (solitary) and the polyzoic (social) Radiolaria is not so important as was once imagined, and it has been found that, contrary to the opinion of Hertwig, the central capsule is in all Radiolaria uninuclear at an early and multinuclear at a later stage. New Radiolaria have been discovered, which, agreeing in the specific characteristics of the skeleton, are some monozoic and some polyzoic. The Monocyttaria and Polycyttaria of Müller are, therefore, no longer to be regarded as important divisions.

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* SB. Jenaisch. Ges. f. Med. u. Nat., 16th Feb., 1883. Cf. Nature, xxix. (1884) pp. 274–6, 296–9.

The objections lately raised by Brandt to the importance of the character of the presence of a central capsule cannot be substantiated, and Häckel is of opinion that this author's views have been based on too narrow an area of investigation. On the other hand, yellow cells have not the importance that was once attributed to them; "they are in no way necessary for the nourishment of the Radiolaria, though they may be important agents in the matter."

The four orders now recognized are the Acantharia, Spumellaria, Nassellaria, and Phæodaria; they are distinct monophyletic groups, and Bütschli was right in laying stress on the fact that the complicated phylogenesis of this section, so rich in specific forms, is a strong argument in favour of the doctrine of descent, and that "in this way those painstaking investigations of the microscopic world (which many 'exact physiologists' consider mere morphological trifling) come to be of real importance."

The Acantharia, which never have a true silicious skeleton, correspond on the whole to the Acanthometræ of J. Müller; the ancestral form of the order appears to be *Actinelius* (first described by Häckel in 1865), and it may be supposed to have arisen from *Actinosphærium* by the hardening of the firmer axial fibres in the radial pseudopodia of the latter into radial spicules.

The Spumellaria are equivalent to Hertwig's Peripylea, Thalassicollea, and Sphærozœa, and are all referable to *Actissa*, in which there is neither an extra- nor an intra-capsular alveolus; it is, perhaps, the ancestral form of all the Radiolaria.

The Nassellaria (Monopylea of Hertwig) are characterized by having a simple area of pores at one pole of the axis of the capsule; the ancestor is to be found in *Cystidium inerme*, which is distinguished from *Actissa* by this restriction of the pores.

The fourth group are better called Phæodaria than Pansolenia (Häckel) or Tripylea (Hertwig), as the only character in common is the possession of the peculiar phæodium—a voluminous dark body of pigment, which lies excentrically outside the central capsule, while the latter has a double membrane and a radiated operculum. The ancestor is the skeletonless *Phæodina.*

The systematic survey of the families concludes with a table of the differential characters of the four orders, a "conspectus ordinum et familiarum," and a hypothetical ancestral tree of the Radiolaria.

**Bohemian Nebelidæ.***—K. J. Taránek describes the structure of the shell and inner envelopes and of the soft parts of these Rhizopoda. He finds they form a transition in their shell-characters from the *Difflugiidæ* to the *Euglyphidæ.* The shell is always more or less laterally compressed. Besides the species in which the shell is constantly colourless, specimens, apparently young, of *Nebela bohemica*, a coloured species, may be found colourless, as occurs in the *Euglyphidæ* and in *Arcella*. In the shell of *Nebela bursella* alone were perforations found, viz. two on each of the narrower sides; their function is, perhaps, to admit water into the spaces inside the shell, between the protoplasmic attachments of the body (called *epipodia* by Taránek), as they occur under similar conditions in *Hyalosphenia*, and the admission of water would have advantages for the animal. Taránek is unable to corroborate Leidy's statement that the smallest tests have the largest chitinous plates. In occasional examples of *Nebela bohemica* and *collaris* the plates are reduced to small granules, scattered over the surface, or they may be absent altogether, and the chitinous membrane left bare, or encrusted with foreign bodies. The plates consist of amorphous silica, as they resist combustion and weak acids and alkalies; strong sulphuric acid dissolves them slightly; they are firmly imbedded in the chitinous membrane, except in *Quadrula*.

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* Abh. Böhm. Gesell. Wiss., xi. (1882) 55 pp. (5 pls.).

With regard to their origin, the author comes to the conclusion that they are formed by the animal itself, from their resemblance to those of the *Euglyphidæ*, which are undoubtedly thus produced. The thickest plates are those of *Lecquereusia*, the thinnest those of *Quadrula*. The chitinous membrane is susceptible of staining, and thus, and from the mode in which foreign bodies are attached to it, evidently itself constitutes the only cementing substance employed; it sometimes projects outside the margins of the plates, and can here attach foreign bodies to itself. The sarcodic body of the *Nebelidæ* has the definiteness of form common to all the *Monothalamia*. As observed in specimens kept without food, the ectosarc is completely hyaline and structure- and colour-less; it is viscous, the outer part more so than the inner, which thus, and by acquisition of granules, gradually passes into the endosarc. The endosarc has usually a pale yellow colour, and contains refractive bodies (microsomata) of two sizes. The nucleus is relatively large, and remains constantly at the back of the body, in the shell; a nucleolus is only occasionally noticed, has a dark or blueish colour, and a globular form; one or more nucleoli (up to five) may occur. A contractile vacuole was always observed, usually one or two; in *Lecquereusia*, *Heleopera*, and *Quadrula* three occur, closely associated. The author frequently finds in *Nebelidæ* chlorophyll masses derived from food, but never showing signs of being produced by the animal itself. The pseudopodia are formed by the streaming forward of the clear ectosarc, which divides into five to nine cylindrical lobes, the body at the same time becoming further removed from the inner wall of the test. The epipodia, when the animal is extended, form long filamentous processes of ectosarc.

The animals live chiefly in peat-moss water, and prefer it when it is low; they either swim, with the mouth downwards, by movements of the extended pseudopodia (five to twelve in number), or creep by means of fewer pseudopodia, which attain the length of the shell, and have a flattened form; they drag the shell after them. Food is seized by and inclosed in a long pseudopodium, and is ultimately massed into small round nutriment-balls. Encystation takes place from June to September; the sarcode previously becomes almost opaque with nutritive substances, which later are resolved into strongly refractive oily globules of different sizes; the pseudopodia are withdrawn, the epipodia become shortened, the contractile vacuoles disappear, the nucleus becomes invisible, and the body withdraws more and more into the hinder part of the test, extruding various excreta such as diatom-shells, which are massed in the mouth of the test, forming the *diaphragm*, which becomes yellowish, probably from iron oxide.

Tarának fully describes and figures with some classificatory and distributional tables the species obtained in Bohemia: viz. *Nebela collaris; flabellulum; carinata; hippocrepis* Leidy; *bursella* Vejdovsky; *bohemica*, a new species with compressed shell without processes, an oval entire pseudopodial opening, provided with a short neck; *americana*, a new species with a shell not compressed, flask-shaped, and devoid of spines; *Heleopera petricola* Leidy; *Quadrula symmetrica* F. E. Schulze; *Lecquereusia spiralis* Bütschli; and a new generic type called *Corythion dubium*, as yet only known by the test; this is small, has a pale yellow tint, is more or less broadly oval, and the pseudopodial opening is subterminal, roundish or oval to half-moon shaped, resembling that of *Trinema acinus*; it is made up of very small, oval, silicious plates (often round near the opening), arranged irregularly, and imbedded in the chitinous layer.

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## BOTANY.

### A. GENERAL, including Embryology and Histology of the Phanerogamia.

**Living and Dead Protoplasm.***—O. Loew returns to the subject of the different reactions of silver salts on living and dead protoplasm. By a fresh series of experiments he claims to have confirmed his previous results that the albumen of living cells alone has the power of reducing the silver, the death of the cell causing a chemical change in the albumen which deprives it of this power.

**Aldehydic Nature of Protoplasm.**†—A. B. Griffiths, after reference to the work of Loew and Bokorny, Reinke, and others, as well as to a previous communication of his own,‡ describes his new experiments.

He has examined the protoplasm of living and dead cells of *Spirogyra*, and finds that it reduces alkaline solutions of cupric salts; that crystals are found in it by treatment with weak sodium chloride, and that the addition of absolute alcohol to the cells of the *Spirogyra* causes the deposition of crystals of anhydrous *dextrose*. It is therefore probable that the reducing properties of protoplasm are due to this glucose, and that the crystals formed with sodium chloride are $C_6H_{12}O_6$, NaCl + $H_2O$.

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* Pflüger's Arch. f. d. Ges. Physiol., xxx. (1883) pp. 348–68. Cf. this Journal, i. (1881) p. 906; ii. (1882) pp. 67, 361, 440, 522; iii. (1883) p. 225.

† Chem. News, xlviii. (1883) pp. 179–80.

‡ Journ. Chem. Soc.—Trans., xliv. (1883) p. 195.

This view is supported by the following experiments:—Albumin (white of fresh egg) mixed with a small quantity of a very dilute solution of dextrose, when treated as above described, behaves in a manner precisely similar to the *Spirogyra* cells. Moreover, if the living plant is kept in the dark for a couple of days, and is then examined, none of these reactions are observed. This is evidently due to the dextrose being used up in the dark to nourish the cell-walls and tissues; for, after a short exposure to sunlight, the dextrose reappears, and the usual phenomena are to be observed in the plant-cells. The author concludes with some remarks on the aldehydic nature of dextrose, on the assimilation of carbon by plants, and on the importance of researches on albumin.

**Embryo-sac and Endosperm of Daphne.***—K. Prohaska brings forward the structure of the embryo-sac and mode of formation of the endosperm of *Daphne* as an illustration of the law that the polar nuclei do not always coalesce to form a secondary nucleus of the embryo-sac; and that the formation of the endosperm may take place without their assistance.

The mature embryo of *Daphne* exhibits clearly two synergidæ and an ovum; while at its lower end is a group of more than three antipodal cells without any cell-wall. While the upper half of the embryo-sac contains but little protoplasm, its lower portion is filled with a dense mass, in which are two quite distinct nuclei with sharp outline, which can be shown to be the polar nuclei. In certain young states of the flower these nuclei are found in the two poles of the protoplasm, which is clearly detached from both the embryonic vesicles, and the antipodals; the lower nucleus subsequently approaches the upper pole; and still later, both are seen near to the embryonic vesicles forming a double nucleus. This double nucleus now moves gradually to the lower part of the protoplasm, which is no longer distinctly separable from the embryonic vesicles; protoplasm collects round it, and the number of antipodal cells increases after fertilization from 2 or 3 to 20. This double nucleus, therefore, corresponds to the secondary embryo-sac nucleus of other plants. It is therefore quite evident that a secondary embryo-sac nucleus is not formed after fertilization by the coalescence of the polar nuclei; but that, while this double nucleus remains, the formation of endosperm commences in the parietal layer of protoplasm by the free formation of nuclei.

The following details are obtained from a number of preparations of *Daphne Cneorum* and *Blagyana*. The parietal protoplasm is often thickened in longitudinal threads, and contains moniliform strings of vacuoles both before and at the beginning of the formation of the endosperm. In it are seen small usually circular or elliptical portions of denser protoplasm filled with minute granules, shown by the application of pigments to be chromatin structures, and which develope into the nucleoli of the endosperm-nuclei. The nucleoli contain a very thin finely granular border of protoplasm; its granules, apparently grouped into short threads, surround the central nucleolus in a radial manner. The layer of protoplasm thus formed becomes gradually detached from the surrounding protoplasm of the embryo-sac, loses its radial framework, and forms at length a clear zone round the nucleolus containing only a few scattered granules.

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* Bot. Ztg., xli. (1883) pp. 865–8 (1 pl.).

The nuclei in the parietal layer are sometimes formed separately, whether in the lower or upper part of the embryo-sac; sometimes in groups.

**Constitution of Albumin.***—From the reaction of superosmic acid O. Loew argues that the leucin and tyrosin compounds do not occur ready formed in the molecules of albumin; but that they are readily produced—especially the benzol-nucleus of tyrosin—when albumin undergoes decomposition. The basis of the formation of albumin he considers to be a process of condensation rather than one of complicated synthesis.

**Fertilization of Sarracenia purpurea.**†—F. Hildebrand describes the mode of pollination in *Sarracenia purpurea*, where the male and female organs are mature at the same time, but their relative position is such that fertilization is almost impossible without the assistance of insects, and self-fertilization is even then rendered very difficult.

He also describes the arrangements for self-fertilization in a water-plant, *Heteranthera reniformis*, and for cross-fertilization in *Salvia carducea*, which differs from other species of the genus in the immotility of its stamens.

**Sexual Relations in Monœcious and Diœcious Plants.**‡—F. Heyer has carried out a number of experiments with the view of determining the causes of the differentiation of sex in unisexual plants. As regards diœcious plants, the result of experiments with 21,000 specimens of *Mercurialis annua* and 6000 of *Cannabis sativa* was that external conditions have no influence on the production of seedlings of one or the other sex. The number of seedlings of each sex is very nearly the same; in the former species the proportion of male to female individuals was about as 105·85 to 100; in the latter, about as 86 to 100. Both species exhibit also secondary sexual differences in the vegetative organs.

A second series of experiments to determine whether external conditions of temperature and soil caused any difference in the proportion of male and female flowers in monœcious plants (*Urtica urens*, *Atriplex*, *Spinacia*, *Xanthium*, Cucurbitaceæ) yielded also only negative results.

The general conclusion is that the sex of the individual is determined at an earlier period than the ripening of the seed; whether before or after fertilization cannot at present be said.

* Pflüger's Arch. f. d. Ges. Physiol., xxx. (1883) pp. 368–73.

† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 455–60 (1 pl.).

‡ Ber. Landwirthsch. Inst. Halle, Heft v. See Bot. Ztg., xli. (1883) p. 873.

**Corpuscula of Gymnosperms.***—J. Goroschankin has investigated the structure of these organs, chiefly in the Cycadeæ, the species examined being *Zamia pumila*, *Ceratozamia robusta*, *Lepidozamia Peroffskyana*, *Encephalartos villosus*, and *Cycas revoluta*. The cell-wall of the young corpusculum is always thin and quite homogeneous. In flowers (of *Ceratozamia*) about four months old, thin places have made their appearance in it in the form of roundish dots. When the ovules are mature (before fertilization) it is strongly thickened, and furnished with a number of conspicuous pits. The cell-wall is at all ages coloured blue by chloriodide of zinc, and is therefore composed of cellulose. Connected with each pit is a small canal, without any trace of the septum apparent; and the protoplasm of the corpuscula is distinguished by a number of protuberances equal in length to the canals.

By treating the fresh endosperm with very dilute sulphuric acid, after the lapse of a day it becomes somewhat softened, and the corpuscles with their thick cell-walls can be easily removed; and, on addition of chloriodide of zinc, the pits in the latter can be very well made out.

Tangential sections in alcoholic preparations of the corpuscula distinctly showed sieve-plates in the pits, by staining with chloriodide of zinc, or better with hæmatoxylin. The sieves were not all alike. In smaller pits they formed a uniform very thin network; in larger pits, besides the network, a coarser striation of the membrane was seen, which, however, passed gradually into the network. The sieve-plates are extremely thin, and require, to make them out, a very careful focusing of Hartnack's objective No. IX. Tinging with hæmatoxylin under very high powers shows that these plates are actually perforated. This can also be seen in longitudinal sections of fresh ovules treated with strong sulphuric acid, and then with iodine or eosin. The sulphuric acid causes a strong and rapid swelling of the cell-wall of the corpuscula, and a rupture of the threads of protoplasm that pass into the canals, the broken ends of which may be readily made out after treatment with iodine.

These observations on the Cycadeæ prove, therefore, that the cell-wall of the corpuscula consists of cellulose; and it appears to be thickened only on that side which faces the protoplasm of the corpuscle. It contains a large number of pits, furnished with true sieve-plates, through which the protoplasm of the cells of the adjacent layer of endosperm is in open communication with the protoplasm of the corpusculum.

Similar sieve-plates were observed in the cell-wall of the corpuscles of a number of Coniferæ belonging to the Abietineæ and Taxineæ; but in the Cupressineæ examined no trace of these pits could be detected.

**Comparative Structure of the Aërial and Subterraneous Stem of Dicotyledons.**†—J. Constantin has made a comparative study of the stem above and below ground in a large number of dicotyledonous orders. The uniformity of the results in particular genera of widely separated orders shows that the differences in question are the result of external conditions rather than of hereditary tendencies; the following are the more important points in which the tissues become modified by being buried in the soil.

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* Bot. Ztg., xli. (1883) pp. 825–31 (1 pl.).

† Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 5–176 (8 pls.).

The epidermis, when present, is modified. Suberin attacks first of all its external wall, and may even form a very thick layer; it ascends only slowly into the lateral and internal walls. The cortex increases, either by increase of the size or number of its cells. The collenchyma either diminishes or disappears altogether, especially when this tissue is enveloped in the angles of the aërial stem. There is a tendency towards the early production of a suberous layer, which appears at different points of the epidermis, in the cortical parenchyma, in the endoderm, in the peripheral layer, and in the liber. This layer is sometimes a substitute for a ring of fibres which is often found outside the liber-bundles in the aërial stem. The underground stem sometimes contains a few fibres, but they are much less numerous.

In the greater number of perennial plants examined the liber-bundles of the aërial stem are closed, being shut up in this ring of fibres; while in the underground stem they are open. The activity of the formative layer is very variable; but lignification almost always takes place irregularly in the woody bundles. The pith is less developed in proportion to the cortex than in the aërial parts. Food-materials, especially starch, exist in it in great abundance. The angles of the aërial stem, when projecting, tend to disappear.

The following phenomena in the underground stem may therefore be attributed to the influence of the environment:—The great development of protective tissues, such as a suberous layer and a suberized epidermis; the reduction or disappearance of the means of support, collenchyma, liber-fibres, &c.; the great development of cortex and relative reduction of pith; feeble lignification; and the production of reserve food-materials.

The proportion of perennial plants increases with the altitude above the sea-level; and the same species is sometimes annual at low altitudes, perennial at high altitudes. The duration of a plant, therefore, and the presence of a rhizome or other form of underground stem, are to a certain extent dependent on external circumstances.

**Junction of Root and Stem in Dicotyledons and Monocotyledons.***—M. C. Potter draws the following comparison between the passage from root to stem in these two classes of plants:—In the procambium of the root the protoxylem or spiral vessels and the protophloem or bast-fibres are first differentiated, the differentiation in each bundle proceeding from without inwards, and thus the separate xylem and phloem bundles are produced. In the stem each bundle consists of xylem and phloem. The protoxylem is first differentiated at the most external part of each bundle, and the differentiation proceeds from within outwards, while the protophloem is first differentiated at the most external part of each bundle, and the differentiation proceeds from without inwards.

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* Proc. Camb. Phil. Soc., iv. (1883) pp. 395-9 (1 pl.).

In Dicotyledons the transformation from the arrangement of the bundles in the stem to that of the root generally takes place in the tigellum; while in Monocotyledons the root arrangement of the bundles continues nearly as far as the point of insertion of the cotyledons in *Phœnix dactylifera*, or of the scutellum in *Zea Mais*.

**Suberin of the Cork-oak.***—A. Meyer gives the general results of some investigations made by Kügler as to the nature of the suberin of *Quercus suber*. The micro-chemical reactions of suberin show that it is nearly allied to the fatty oils. Its molecules are so closely associated with those of cellulose, that boiling chloroform, while extracting the whole of the crystallizable cerin, removes only about 25 per cent. of the suberin. It is, however, completely extracted by treating first with chloroform and alcohol and then with an alcoholic potash-ley. Kügler regards it as a fatty oil, composed chiefly of stearin $(C_{18}H_{35}O_2)_3C_3H_5$ and the glycerin-base of a new acid, phellonic acid $C_{22}H_{42}O_3$, with melting-point 96° C. Forty per cent. of the mixture of these acids, and 2·5 per cent. glycerin was obtained from cork.

Suberin is therefore closely allied to the tallows, and especially to Japan tallow, which, besides palmitin, contains the base of an acid with high melting-point 95° C., obtained from the parenchyma-cells of *Rhus succedanea*, a substance apparently identical with that which causes the suberization of the cell-walls.

**Influence of Pressure on the Growth and Structure of Bark.**†—A. Gehmacher finds that pressure exercises a considerable influence on the growth of bark, the separate elements being altered as definitely as those of the wood.

As regards cork, the greater the pressure the fewer cork-cells are formed, and the less the pressure the more numerous are they. The radial diameter of the cells is also affected by the pressure.

The cells of the primary cortical parenchyma undergo a similar change; but they appear to be compressed not only radially, but also laterally, becoming more or less angular towards those cells which were formed under less tension and have a more nearly globular form. The intercellular spaces disappear entirely with increased pressure, increasing perceptibly in size with its decrease. The sclerenchymatous elements are least affected by change of pressure. The bast-fibres increase considerably in number with diminution of pressure; when the pressure is very great very few bast-fibres or none at all are formed. Both the wood-fibres and bast-fibres increase in size with diminished pressure.

**Relation of Transpiration to Internal Processes of Growth.**‡—According to P. Sorauer, transpiration results from two sources, viz. the water derived from processes of oxidation within the plant, and that which serves as a mechanical transport of material and passes unchanged through the plant. It may therefore be compared to the perspiration of animals, and is intimately connected with the process of oxidation within the plant.

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* Ber. Deutsch. Bot. Gesell., i. (1883); Generalvers. in Freiburg, xxix.–xxx.

† SB. K. Akad. Wiss. Wien, lxxxviii. (1883) (1 pl.).

‡ Forsch. aus d. Geb. der Agriculturphysik, vi. (1883) p. 79. See Naturforscher, xvi. (1883) p. 470.

It results from this hypothesis that the transpiration from the leaf per unit of surface must be less, the less active the internal activity of growth, or, in other words, the larger the amount of surface which goes to the production of a given weight of dried substance. The correctness of this view was proved by the following experiments:—Young seedling cucumbers, 10 cm. long and of an average weight of 1·5 g., were each placed on June 14 in a vessel of two litres capacity, containing 1700 g. of leaf-mould, and 400 g. water. On July 17, the plants had an average leaf-surface of 1700 g., and had transpired 454 g. water. Five fully developed leaves were now removed from one plant, having a superficies of 525·2 sq. cm., and a weight of 9·42 g. These plants, from which one-half of the leaf-surface had now been removed, maintained the same amount of transpiration as the uninjured ones, showing that the surface which remained must have performed a portion of the work of the leaves that had been removed. On August 3 a still further quantity of leaves with a superficies of 88·8 sq. cm. and a weight of 8·2 g. was removed. Since the first denudation the plant had grown very quickly, having formed 10 leaves with a superficies of 1121·79 sq. cm. At the same time 16·2 g. were removed from a second plant, having a superficies of 264·1 sq. cm. After fourteen days the amount of transpiration was again nearly the same from all the plants. Those which had been denuded showed no decrease of transpiration, the substance removed being replaced by a rapid fresh production of leaf-surface. A second series of experiments gave similar results.

Transpiration was also shown to be dependent on the concentration of the nutrient solutions. Experiments were made on four different species of cereals, with five different concentrated solutions, and the transpiration was found to be less in proportion to the concentration of the fluid. With those solutions in which the plant grew most rapidly, the absolute amount of transpiration was large, as was the general metastasis, but the relative proportion to the weight of newly formed substance was very small.

The following is Sorauer's explanation of these phenomena. A maximum transpiration accompanies the rapid production of substance in an optimum nutrient solution. But for this fresh production a certain quantity of mineral constituents is indispensable, and these are absorbed by the roots out of the fluid. When this solution is very dilute, a larger quantity of water must be carried up; and thus, with the increase of the mechanical water of transpiration, the total quantity of water transpired increases above the optimum with the decreasing concentration of the fluid.

**Easily Oxidizable Constituents of Plants.**[*]—It is a well-known fact that the juices of many plants become discoloured on exposure to the air; so, too, sections of stems and roots, of leaves, and fleshy fruits which acquire a brown colour on exposure. Little has been ascertained in regard to the physiology of these changes. They obviously depend upon the oxidation of certain constituents; this is seen, for instance, on exposing grated potatoes to the air, when the uppermost layer assumes a brown colour, which by frequent turning over of the mass may be communicated throughout. The same is seen in the case of the expressed juice of the potato. Putrefaction or fermentation, and reducing agents, such as sulphurous or hydrosulphuric acid, decolorize these fluids. The juice of the white sugar-beet is even more sensitive, becoming on exposure to the air immediately of a dirty wine-red colour, then violet, brown, and finally almost black. These facts indicate the presence in plants of easily oxidizable bodies, and inasmuch as the products of their oxidation do not occur within the uninjured cells, it follows that there is either no free oxygen in the latter, or that these oxidizable substances are accompanied by other reducing substances, which hinder their oxidation, or again, that in the protoplasm oxidation affords other uncoloured products. Upon which of these three factors the colourless state of the protoplasm and cell-sap of living plants depends is not yet decided.

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[*] Zeitschr. Physiol. Chem., vi. (1883) pp. 263–79. See Journ. Chem. Soc.—Abstr., xliv. (1883) pp. 880-1.

In the study of oxidation processes in the living plant-cell, an important question presents itself, as to whether substances occur in the cell, which at ordinary temperatures unite with atmospheric oxygen without the essential co-operation in this process of the living protoplasm. Difficult as the problem is, the isolation and determination of the constitution of these easily oxidizable substances forms an indispensable preliminary step. It may be conjectured that they belong to the aromatic series. In this connection the numerous hydroxybenzene derivatives claim attention, of which many are known to be easily oxidizable. Pyrogallol in alkaline solutions greedily absorbs oxygen and becomes decomposed into carbonic anhydride, acetic acid, and a brown body of unknown nature. The dihydroxybenzenes (catechol, resorcinol, and quinol) are easily oxidizable bodies, and their methyl derivative, orcinol, is coloured red by the air. As regards derivatives of the anthraquinone series, there is the change of indigo white into indigo blue, and the behaviour of *Boletus luridus*, the colourless section of which becomes at once blue on exposure to the air. Lastly, there is a series of complex plant-constituents, undoubtedly benzene derivatives, although their constitution has not yet been ascertained, which exhibit many analogies to the discoloration of plant-juices. Of these brazilin may be named, the colourless aqueous solution of which becomes first yellow, then reddish yellow in the air.

J. Reinke, in his endeavours to isolate the easily oxidizable constituents of the sugar-beet and potato to which the discoloration of their respective fluids is attributable, succeeded in the first instance in isolating from the beet-root a chromogen which on exposure to the air acquired a red colour. This substance he has accordingly designated *Rhodogen*. The product of its oxidation he terms *beet-red*, and he notes certain remarkable analogies between the absorption-bands of this substance, and of the colouring matter of *Anchusa tinctoria*, alkanet red, the spectrum of each showing three bands occupying identical positions. These investigations have therefore so far afforded proof of the existence in the colourless cells of the sugar-beet of an easily oxidizable colourless body, capable of isolation, which by itself, without the aid of the living protoplasm of the plant, can split up the oxygen molecule, forming a coloured substance.

The isolation of the chromogen of the potato has not succeeded so satisfactorily. The presence of vanillin in the juice appeared to be shown by the strong odour of vanilla. Vanillin has been detected by Scheibler in raw beet-sugar. A substance resembling catechol, but not identical with it, was also separated. It would seem to be the same body discovered by Gorup-Desanez in the leaves of the Virginian creeper. It is undoubtedly an acid, and, amongst the known aromatic acids, most closely corresponds in its reactions with hydrocaffeic acid. In conclusion, the author suggests the hypothesis that these easily oxidizable bodies belong, in their physiological relations, to the retrogressive series, perhaps originating from the breaking up of albumin, or formed by the synthesis of the products of such decomposition, and that in these features the process is allied to that of respiration.

**Action of Light on the Elimination of Oxygen.***—The following are the main results of a series of experiments by J. Reinke on *Elodea*:—

The evolution of oxygen which is dependent on light begins with a mean illumination and increases *pari passu* to a maximum with increasing intensity of light, this optimum corresponding nearly to direct sunlight; any further increase in the intensity of light does not increase the development of gas. Indicating the intensity of ordinary direct sunlight by 1, one-fourth that amount by 1/4, and four times that amount by 4/1, the two lower rows in the following table indicate the number of bubbles given off in 1/4 minute in two different experiments:—

| 1/1 | 4/1 | 16/1 | 36/1 | 64/1 |
|---|---|---|---|---|
| 30 | 32 | 31 | 26 | 27 |
| 28 | 31 | 28 | 30 | 29 |

In light of 800/1, the plant gave off in two minutes the same number of bubbles as in ordinary sunlight; the stream then ceased, the chlorophyll being bleached. In light of from 64/1 to 300/1 intensity, the gases exhaled do not contain more carbonic acid than that produced by the green plant in ordinary sunlight. From all these facts he draws a conclusion unfavourable to Pringsheim's hypothesis that chlorophyll acts as a protecting screen against the light.

**Red Pigment of Flowering Plants.**†—H. Pick points out that those organs of flowering plants in which carbo-hydrates are present in large quantities, and in which they undergo transport from place to place, are very commonly coloured red. This is especially the case with the young branches of trees and other perennial plants, such as the oak and rose, and with the earliest spring-leaves, the leaf-stalks, and the principal veins of the upper surface of the leaf. But this colouring is, as a rule, confined to those parts which are exposed to the direct action of the sun, and is always directly connected with the presence of tannin. Transverse sections through young leaf-buds of the rose show that the entire epidermis of every leaflet up to the cone of growth is impregnated by a hyaline and strongly refractive mass, as also are those cells which are afterwards distinguished as the conducting cells of the carbo-hydrates, such as the vascular sheaths This opalescent substance is readily proved to be tannin. As the red tinge developes in these parts, the refringency gradually diminishes, the tannin becoming transformed into the red pigment. With regard to the localization of the tannin which undergoes this transformation, it may occur either almost entirely in the epidermis, as in the hazel, beech, vine, and many other plants, or both in and below the epidermis, as in the horse-chestnut, privet, elder, &c.; less often it is not found in the epidermis, or only in slight traces, as in the different species of poplar and willow.

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* Bot. Ztg., xli. (1883) pp. 697-707, 713-23, 732-8.

† Bot. Centralbl., xvi. (1883) pp. 281-4, 314-8, 343-7, 375-83 (1 pl.).

The conditions under which this red pigment is formed are the direct action of sunlight and a low temperature, but more especially the former, differing in this respect from the red pigment of autumn leaves, the formation of which is due chiefly to a low temperature. If seeds of maize germinate in the dark, the young plant developes without a trace of red colour, which, however, makes its appearance as soon as they are exposed to the sun, especially in the tigellum. The same is usually the case with the veins on the under side of the leaf; and the colour is always most intense on the side of the stem which is most exposed to the sun. The leaves of *Begonias*, and some other plants, form an exception to this rule, the colouring being most intense in the veins on the under side. Plants in which only a very small quantity of tannin is formed, as the Solanaceæ, Oleaceæ, the laburnum, mulberry, &c., display scarcely any red coloration.

The vertical position of the majority of stems removes them to a large extent from the direct light of the sun, and they show, as a rule, but little colour; this is strongly contrasted with the prevalent red colour of the upper side of creeping stems, such as the stolons of the strawberry, species of *Potentilla*, &c. The petioles of leaves, and the separate pedicels of flowers in an inflorescence are, on the other hand, very commonly more or less deeply coloured. In tropical countries the colouring is much more universal and intense than with us.

Spectroscopic analysis of the red pigment shows that it completely absorbs the yellow and green rays from D to *b*, partially those from *b* to a little beyond F, and the ultra-violet. The rest of the spectrum is bright, the brightest portion lying between B and C, and on both sides of G. These are, on the other hand, the most strongly absorbent portions of the spectrum of chlorophyll.

The pigment is readily soluble in cold water, and the effect was ascertained of growing plants behind a screen of the solution. It was found that the chromatophores turn green, and assimilate under these circumstances, and that the red light is especially favourable to the absorption and transport of starch. This clearly indicates the purpose of the red pigment in the young shoots and other parts of the plant; and the same is the explanation of the red colour of autumn leaves. Different portions of a large leaf of *Ricinus communis* were exposed to (1) light passed through ruby glass; (2) light passed through orange-coloured glass; (3) light passed through an aqueous solution of the red pigment of the red beet. After four hours: in (1) the starch was found chiefly in the conducting tissue; in the palisade-cells there was not a trace of it. In (2) no important result was found. In (3) the starch had transferred itself from the palisade-tissue to the conducting mesophyll of the leaf.

Crystals of calcium oxalate are very commonly found in the palisade-cells and in the underlying mesophyll; and these the author believes to have an important function in connection with the transformation of starch into other substances; which, however, requires further investigation.

**Coloured Roots and other coloured parts of Plants.**[*]—F. Hildebrand describes the following parts of plants which are coloured in an unusual manner.

The roots of *Pontederia crassipes*, which hang down in the water, are of a dark violet-blue colour, due, not to any pigment in the cell-sap, but, like those of *Fossombronia pusilla*, to the cell-wall itself being coloured. The under side of the floating leaves is provided, which is very unusual, with stomata, the colour being also here in the cell-wall of the guard-cells and adjoining epidermal cells. Hildebrand suggests that the purpose of this colouring may be to render the parts in question less visible to animals.

*Wachendorfia thyrsiflora* has bright red roots due to a coloured fluid substance in the cells; and presents the very remarkable phenomenon of the pigment being formed even in absolute darkness.

The bright red colour of the fruit of *Rivina humilis* is produced, like that of the bracts of *Euphorbia fulgens*, by the superposition of cells containing different pigments, orange and violet-red.

In relation to the above paper, P. Ascherson[†] gives a description of the instances known to him in which coloured roots occur in plants belonging to the orders Pontederiaceæ, Hæmodoraceæ, and Cyperaceæ.

**Starch in the Root.**[‡]—A. Tomaschek finds that the starch-containing cells of the root are confined to the layer of meristem between the root-cap and the body of the root, the remaining tissue of the apex of the root not exhibiting a trace of starch. Shortly after the first roots had emerged from the seed and taken a geotropic direction, the starch had already disappeared from the apex of the root, or was found in only a very few cells.

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[*] Ber. Deutsch. Bot. Gesell., i. (1883); Generalvers. in Freiburg, xxvii.-xxix.

[†] Ibid., pp. 498-502.

[‡] Oesterr. Bot. Zeitschr., xxxiii (1883) pp. 291-3.

**Proteids as Reserve-food Materials.*** —M. C. Potter has examined a large number of leaf-buds, rhizomes, tubers, corms, and bulbs, with a view to determine the presence of proteid-granules or crystalloids. In none of them, with only one exception, did he find any, although starch was present in abundance; but this may have been due in some cases to their having already germinated. The exception was in bulbs of *Narcissus poeticus*, where proteid-granules were formed of relatively large size, and apparently only one in each cell. They consisted of an outer hyaline and an inner opaque part, the latter being soluble in dilute potash. They were insoluble in ether, alcohol, acetic acid, or solution of sodium chloride, and were stained orange yellow by iodine. They disappeared soon after the bulb had commenced to grow.

**Leucoplastids.**†—A. F. W. Schimper, replying to the opposite view of A. Meyer,‡ reaffirms his theory that the protoplasm of leucoplastids is itself used up in the formation of starch, supporting it by the statements that in many plants the leucoplastid crystals occur only in the epidermis where no formation of starch takes place; and that the crystals eventually entirely disappear in those cells where abundance of starch is formed. That it is the albumen itself which crystallizes, he argues from the fact that protein-crystals are often found in leucoplastids, and from various other considerations.

**Cleistogamous Flowers.**§—T. Meehan describes cleistogamous flowers in *Nemophila maculata*, *Impatiens pallida*, and *Viola sarmentosa*, all of which produce abundance of seeds, no perfect corollas being observed on any of them. *Opuntia leptocaulis* produced a number of small flower-buds, some of which opened. These resulted in fruits which took a full year to mature, becoming a bright rosy red, but containing no seeds.

**Cultivation of Plants in Decomposing Solutions of Organic Matter.**‖—V. Jodin chose for his experiments vegetable débris, or pulverized plants, which were dissolved in distilled water; on the surface of these were placed the grains of experiment; as decomposition went on the grains germinated and fructified, by assimilating part of the mineral elements and some of the nitrogen of the solution. At the end of three or four months the liquid was found to be limpid and odourless; on evaporation it left a residue of potash, which appeared to be united to a brown organic body; on calcination nitric acid could be detected.

The author gives a table of the weights of material used, from which it is seen that of the primitive nitrogen 35 or 36 per cent. has disappeared; and concludes by suggesting that the method of experiment which he has adopted will be found to be of use in the investigation of certain problems of plant physiology.

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* Proc. Camb. Phil. Soc., iv. (1883) pp. 331–3.

† Bot. Ztg., xli. (1883) pp. 809–17.

‡ See this Journal, iii. (1883) p. 289.

§ Bull. Torrey Bot. Club, x. (1883) pp. 119–20.

‖ Comptes Rendus, xcvii. (1883) pp. 1506–7.

**Disease of the Weymouth Pine.***—R. Hartig attributes the disease to which this pine is so liable in Germany to the fact of the thinness of its cork-layer, owing to its native habitat, the boggy lowlands of North America. It is therefore unable to resist the very high transpiration from the heat of the sun in Central Europe, which results in the drying up of the bark and cambium, especially on the southern and western sides, thus rendering the trunk extremely subject to the attacks of fungi, such as *Agaricus melleus*, *Coleosporium Senecionis*, and *Trametes radiciperda*.

**Flora of Spitzbergen.**†—A. G. Nathorst gives the following as the main results of two visits to Spitzbergen in 1870 and 1882:—

1. The flora of Spitzbergen is richer than that of any other country of the same latitude, except possibly Grinnell-land; and it is probable that there are still vascular plants remaining to be discovered.

2. The larger part, at all events, of the Arctic flora avoids the coast, and attains its richest development in the most continental regions.

3. During the glacial period, only a very few species, if any, could have maintained themselves in Spitzbergen; most or all of those which now constitute its flora must have migrated there during the post-glacial period.

4. About 75 per cent. of the vascular plants flourish there and produce seeds. These are probably the species which migrated first.

5. The remainder, mostly bog- and shore-plants, are the survivors of a portion of the post-glacial period when the climate was warmer than it is now; these migrated later than the others.

6. The migration of the Spitzbergen flora took place over land, with perhaps a few exceptions.

7. This land formed a now submerged connection between Spitzbergen, Nova Zembla, Arctic Russia, and Scandinavia, from which countries the flora is derived.

8. No interchange with Greenland took place during the quaternary period, except perhaps accidentally.

## B. CRYPTOGAMIA.

### Cryptogamia Vascularia.

**Fructification of Fossil Ferns.**‡—R. Zeiller has examined and described a large number of ferns from the "terrain houiller," where they are very abundant, though the fructification is comparatively rare. From the remains which he has been able to examine, chiefly from the Pas-de-Calais, he gives detailed descriptions of the following genera:—

I. Sporangia grouped into a synangium, and partially united:—Marattiaceæ. Sporangia without annulus. Genera:—*Crossotheca* n. g.—

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* Unters. aus d. Forstbot. Inst. München, iii. (1883) pp. 145–9. See Bot. Centralbl., xvi. (1883) p. 304.

† K. Svensk. Vetensk.-Akad. Handl., xx. (1883). See Naturforscher, xvi. (1883) p. 457.

‡ Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 177–209 (4 pls.).

sporangia pendent in the form of a fringe; pinnæ dimorphic. *Calymmatotheca* Stur. *Dactylotheca* n. g.—sporangia exposed, especially on the inferior lobes, almost like the fingers of a hand. *Renaultia* n. g.—sporangia resembling those of *Angiopteris*, but isolated. *Myriotheca* n. g.

II. Sporangia with annulus:—*Senftenbergia* Corda. *Oligocarpia* Göp. (Gleicheniaceæ). *Hymenophyllites* Göp. (Hymenophyllaceæ). *Diplotmema* Stur. *Grand'Eurya* n. g., nearly allied to *Zygopteris*.

The author considers that the family Botryopteridaceæ formed by Renault should be regarded as ranking with Gleicheniaceæ, Cyatheaceæ, and Polypodiaceæ, if not with Marattiaceæ.

**Prothallium of Struthiopteris germanica.***—D. H. Campbell has cultivated the spores of this fern, and finds the prothallium to be distinctly diœcious. The male and female prothallia differ somewhat in form, the former being more distinctly heart-shaped.

## Muscineæ.

**Mucilage-organs of Marchantiaceæ.**†—Organs containing mucilage have been recently described by several observers in different species belonging to the Marchantiaceæ. R. Prescher has examined them in detail, with the following results:—

Organs of this kind occur in a large number of species, usually in the form of isolated mucilage-cells, as in *Marchantia polymorpha*, *cartilaginea*, *chenopoda*, and *paleacea*, *Preissia commutata* and *quadrata*, *Clevea hyalina*, and *Plagiochasma Rousselianum*. *Fegatella conica* contains in addition mucilage-tubes. The mucilage-cells occur in the thallus, and in the male and female receptacles, and especially in the tissue without intercellular spaces; they are found in the greatest numbers immediately beneath the layer which contains the air-chambers; less often they occur also in the epidermis, as in *M. cartilaginea* and *chenopoda*; and in the septa of the air-chamber layer, as in *M. chenopoda*, *Clevea hyalina*, and *Plagiochasma Rousselianum*. The mucilage-tubes of *Fegatella conica* are found exclusively in the tissue of the mid-rib of the thallus, which has no intercellular spaces.

All the organs which contain mucilage are differentiated at a very early period near the growing points. They are distinguished in their youngest state by their thin cell-walls and abundant protoplasm. Several segments usually go to the formation of a mucilage-tube.

The mucilage is formed out of the protoplasm, which never contains starch. It lies in contact with the primary cell-wall, in the form of a thin layer which gradually becomes thicker, and displays from the first its peculiar chemical and physical properties. It is highly refractive, and has great power of swelling; treated with alcohol, it displays stratification, and a brownish colour; its yellow reaction with iodine and sulphuric acid indicates an affinity with vegetable gum. In older parts of the thallus both cells and tubes are completely filled by mucilage; protoplasm is essentially concerned in its formation.

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* Bull. Torrey Bot. Club, x. (1883) pp. 118–9.

† SB. Akad. Wiss. Wien, lxxxvi. (1882) pp. 132–58 (2 pls.).

The fact that the cells themselves increase in size during the formation of mucilage, necessitates the hypothesis that intussusception takes an active part in the formation of all those layers which are formed before the completion of the growth of the cells. If growth took place by apposition only, the layers would be formed only after the cells had obtained their full size.

The walls of the mucilage-tubes do not assume a condition capable of swelling during their development, but retain their structure to the end. The death of the thallus causes the tubes to open in succession and discharge their contents. The disorganization of the mucilage-cells in the end of the thallus takes place in the same way.

Nothing can be said with certainty with regard to the physiological function of the mucilage-organs of the Marchantiaceæ, but it is probably connected with their great power of swelling, owing to the capacity of their contents for absorbing water.

### Characeæ.

**Characeæ of the Argentine Republic.***—C. Spegazzini describes six species of *Nitella*, with four forms, one of *Lamprothamnus*, and three of *Chara*, with two forms. The species of *Lamprothamnus* is new, and is thus described:—*L. Montevidensis* Speg. Maximus, crassus, capitato ramosus, ecorticatus, monoicus. Antheridia globoso-polygona, rufo-fusca v. rufo-rubra (0·20–0·22 mm. diam.); sporangia ad basin antheridiorum enata, infera, globosa (0·30–0·35 mm. diam.), rubescentia, subinconspicue 5–7 gyrata, apice coronula mammiforme, obtusa breviusculaque ornata. Near Montevideo.

**American Species of Tolypella.**†—The two families into which the Characeæ may be divided are distinguished by the structure of the corona of the sporangium (archegonium), which consists in the Chareæ of five, in the Nitelleæ of ten cells; in some species of the latter family it is evanescent. The Nitelleæ again may be divided into two genera, distinguished chiefly by the position of the antheridium, which in *Nitella* is apical, on the primary ray of the leaf, the archegonia being lateral on the node below the antheridium; and the leaves having but one leaf-bearing node. In *Tolypella* the antheridia are one or several, lateral on the nodes of the leaf and leaflet; the leaves have from one to three nodes bearing leaflets.

T. F. Allen gives a full account of the American species of *Tolypella*, and proposes the following general classification of the twelve known species of the genus, of which four are now described for the first time:—

I. OBTUSIFOLIA.—Corona evanescent; sterile leaves undivided.
  A. Ultimate cell of the primary ray of the leaf longer than the other cells. 1 sp.:—*T. longicoma* A. Br.
  B. Ultimate cell not longer. 4 sp.:—*T. nidifica* Leonh.; *T. Normaniana* Ndst.; *T. glomerata* Leonh.; *T. comosa* Allen.

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* Ann. Soc. Cientif. Argentina, xv. (1883) pp. 218–31. See Bot. Centralbl., xvi. (1883) p. 257.

† Bull. Torrey Bot. Club, x. (1883) pp. 109–17 (6 pls.).

II. Acutifolia.—Corona persistent.

A. *Indivisa.* Sterile leaves undivided. 2 sp.:—*T. prolifera* Leonh.; *T. fimbriata* Allen.

B. *Divisa.* Sterile leaves divided, usually into four terminal leaflets. 5 sp.:—*T. californica* A. Br.; *T. stipitata* Allen; *T. intricata* Leonh.; *T. intertexta* Allen; *T. apiculata* A. Br.

### Fungi.

**Rabenhorst's Cryptogamic Flora of Germany (Fungi).**[*]—The publication of this important work has now advanced as far as the issue of the first division of the first volume, which is to comprise the Fungi, under the editorship of Dr. G. Winter. The present division includes the Schizomycetes, Saccharomycetes, and Basidiomycetes, all the species being described which are natives of Germany, Austria, and Switzerland.

**Hysterophymes.**[†]—H. Karsten applies this term to elementary organs which have been mistaken for independent living animal or vegetable organisms. In the present paper he explains the process by which he has developed them synthetically by constructing artificial cells of potato digested in a nutrient fluid of about 5 per cent. solution of sodium-ammonium phosphate with some potassium sulphate. In such cells albumen-cells may be seen to develope, and to multiply in a linear direction into the well-known bacterium, bacillus, and vibrio forms. The contents of these bacterioid organisms are coloured blue by iodine in a certain stage of development. On the addition of a solution of cane-sugar, the bacterium-cells formed within the closed potato-cells can be seen to increase and develope into the torula-form.

Cells of the kohl-rabi digested in the same nutrient fluid developed in the same way micrococci and bacteria; and, since they were taken from the bast-tissue, where there are no intercellular spaces, Karsten regarded any entrance of germs from without as impossible. The author considers the experiments to prove that the so-called ferment-cells arise from normally developed cell-sap vesicles, and that torula-cells are only a stage of development of bacterium-cells or micrococci.

**Graphiola.**[‡]—This exotic genus of Fungi is chiefly known from *G. Phœnicis* parasitic on *Phœnix dactylifera* and its varieties, as *P. canariensis*, also on *Chamærops humilis*, and has been variously referred to the Myxomycetes, Uredineæ, and Pyrenomycetes. E. Fischer has undertaken a detailed examination of it, as well as of three other species, *G. congesta*, parasitic on *Chamærops palmetto*, and *G. disticha* and *compressa*, the hosts of which are not known with certainty, and may belong to quite another genus.

The fructification of *G. Phœnicis* consists of small black elevations on both sides of the leaf of the date-palm, of a diameter about 1·5 mm.

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[*] Rabenhorst, L., 'Kryptogamen-Flora von Deutschland, Oesterreich u. d. Schweiz. 1ter Band, Pilze, von G. Winter, 1te Abtheilung.' Leipzig, 1884.

[†] Flora, lxvi. (1883) pp. 491–8.

[‡] Bot. Ztg., xli. (1883) pp. 745–56, 761–73, 777–88, 793–801 (1 pl.).

and a height of 0·5 mm. From the middle projects a yellow columnar body, about 2 mm. in height, composed of a number of vertical filiform bodies rising from its base, the space between them being completely filled by a mass of yellow spores. The fructification may be regarded as consisting of four parts, an outer peridium, an inner peridium, a spore-forming layer, and a tuft of hyphæ.

The outer peridium consists of a circular wall which spreads over the epidermis of the leaf of the host; it varies greatly in thickness, and consists of a number of branched hyphæ. This is bounded on the inside by a very delicate membrane, the inner peridium.

The hyphæ which are destined to the formation of spores spring from the central part of the peridium; they are vertical to the surface of the leaf, and form a continuous palisade-like layer. The ends of these hyphæ are thicker than those of the hyphæ which compose the sterile weft; they increase gradually in diameter upwards, attaining at the apex a thickness of about 3–4 $\mu$. They are colourless, and filled with protoplasm which is either homogeneous or more refringent in some parts than others; they are septated tranversely into short cells, which at length swell into a spherical or ellipsoidal shape and become readily detached from one another. On the upper of these cells small protuberances now make their appearance, which gradually increase in size till they have attained that of the cells from which they spring; from three to six of them springing from one of the cells of the hyphæ. They are thin-walled and filled with protoplasm of varying refrangibility, which has passed into them from that of the hyphal cell, which eventually perishes. These bodies, which the author calls "spore-initials," produce the spores by one or more bipartitions of their contents. The ripe spores are usually found connected together in pairs; they are spherical or ellipsoidal, and about the same size as the initials, 3–6 $\mu$ in diameter; their membrane is usually moderately thick, colourless, and smooth.

The tufts of sterile hyphæ spring, like the fertile ones, from the bottom of the fructification. They are slender, cylindrical, or irregularly prismatic bodies, from 7–18 $\mu$ in thickness, and strongly refringent. Each larger bundle consists of from 50 to 100 of such hyphæ; their membrane is much thicker and more refringent than that of the fertile hyphæ, but the refrangibility differs greatly in different parts of the same hyphæ. Their mode of formation is very similar to that of the fertile hyphæ. As they develope they carry up with them the spores, which become attached to them, outside the outer peridium, where they are ready for dissemination.

The spores appear to retain their power of germination for a period of from three to four months. They germinate either directly with the formation of a septated germinating filament, or with the intervention of a single cylindrical sporidium produced from each spore. The germinating filaments grow to a length of 400 $\mu$; their further development was not observed. There is no reason for believing that the genus has any heterœcism or alternation of generations.

As regards the systematic position of *Graphiola*, the author does not agree with any of the views hitherto brought forward, but considers it as most nearly allied to the Ustilagineæ; differing from them in its highly complex fructification. Until transitional forms have been found, he would erect it into a separate but closely allied family under the name Graphiolaceæ.

**Pourridié of the Vine.***—R. Hartig believes that the cause of this disease is not as supposed, the "rhizomorph" of *Agaricus melleus*, but a different fungus, *Dematophora necatrix* n. sp., clearly distinguished from the former by its peculiar apical growth, the formation of sclerotioid agglomerations in the mycelium, and the form of the fructification. The mycelium is parasitic, and rapidly kills not only the vine, but many other trees which it attacks. Under favourable conditions, it forms great numbers of branched conidiophores; but since the perithecial form is at present unknown, the systematic position of the genus must remain at present undecided. *Roesleria hypogæa* he regards as saprophytic, and a secondary cause only of the disease.

E. Prillieux,† on the other hand, while agreeing with Hartig that the disease is not caused by *Agaricus melleus*, looks on *Roesleria hypogæa* as its true source. The coremium-like spores of this fungus he regards as ascospores, formed eight in each ascus.

**Oospores of the Grape Mould.**‡—E. Prillieux states that he has received from M. Fréchou of Nérac germinating oospores of *Peronospora viticola*. The germinating oospores produce at once a mycelial tube similar to that known in other species of *Peronospora* in which the germination of the oospores has been seen. This is an important step in our knowledge of the grape-mildew, since, inasmuch as the conidia produce zoospores, it had been supposed by some that the oospores would also produce zoospores, as is the case in the related genus *Cystopus*.

**Pleospora gummipara.**§—The fungus named by Beyerinck *Coryneum gummiparum*, connected with the flow of gum from woody trees, has now been found by C. A. J. A. Oudemans in the perithecial form, and been identified as belonging to the genus *Pleospora*, Sect. *Eupleospora*. As it cannot be identified with any species hitherto known, Oudemans calls it *Pleospora gummipara*, and describes the perithecial, pycnidial, and conidial forms.

**Schizomycetes.**‖—F. Neelsen gives a very useful epitome of the present state of our knowledge respecting the life-history and classification of this class of organisms, referring chiefly to the labours of Ehrenberg, Cohn, and Zopf. In the mode of investigation adopted by the last-named authority, and the theory of the pleomorphism of the different organisms comprised in the class,* he sees the promise of a fuller and more accurate knowledge in the future of their life-history.

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* Hartig, R., 'Der Wurzelpilze des Weinstockes,' 18 pp., Berlin, 1883. Also Unters. aus d. Forstbot. Inst. München, iii. (1883) pp. 95–140; and SB. Bot. Ver. München, Jan. 10, 1883. See Bot. Centralbl., xvi. (1883) p. 208.

† Prillieux, E., 'La pourridié de la vigne, &c.,' 13 pp. (1 pl.), Paris, 1882. See Bot. Centralbl., xvi. (1883) p. 208.

‡ Bull. Soc. Botan. France. Cf. Science, ii. (1883) p. 831.

§ Hedwigia, xxii. (1883) pp. 161–2.

‖ Biol. Centralbl., iii. (1883) pp. 545–58.

**Fæcal Bacteria.**†—B. Bienstock has made a detailed examination of the bacteria found in human fæces under a great variety of circumstances. Those obtained from healthy men he found to belong exclusively to the group *Bacillus*, their spores having alone a sufficient power of resistance to the antiseptic action of the gastric fluid. Of this group five distinct forms were observed:—1 and 2. Two large forms, resembling *B. subtilis* in form and appearance, but differing in the mode of germination of the spores, and in not having the power of spontaneous motion. Although always present in the fæces, the author was unable to determine that these bacilli take any part in the fermentative processes of the intestinal canal; and they appeared to have no pathogenous properties. 3. A third form was characterized by its very slow growth and minute size; it acted pathogenetically on mice. 4 and 5. These two forms, invariably present in human fæces beyond the age of suckling, are of the greatest importance in the processes carried on in the digestive canal beyond the stomach. They were of different chemical properties, one bringing about decomposition of albumen, the other of carbohydrates; the second only was present in the fæces of infants fed only on milk. These forms alone have the power of decomposing albumen or carbohydrates; the one producing the well-known products of the decomposition of albuminoids, the other splitting up sugar into alcohol and lactic acid. The first produced no decomposing effect on saccharine solutions; the second none on solutions of albuminoids; though both multiplied freely. The other fæcal bacilli, and those obtained from the air, were also without the least effect. After cultivation for from twenty to forty generations these two forms still retained their power.

The author derives from these experiments the conclusion that the decomposition of albuminoids and carbohydrates in the intestinal canal is due in each case to one specific bacterial form, which brings about the decomposition without the assistance of any others.

**Influence of Oxygen at high pressure on Bacillus anthracis.**‡—J. Wosnessenski comes to the conclusion that Bert was right in regarding oxygen at very high pressures as being mortal to the protoplasm of *Bacillus anthracis*; but it is not to be supposed that a gradual augmentation in the pressure of the oxygen will gradually lead to the loss of vitality; till the pressure exceeds that of fifteen atmospheres of air the organism resists it better than it does oxygen at a normal pressure. The results obtained with increasing pressure vary considerably, according as the experiments are conducted with thick or thin layers; with the latter the influence of pressure is not marked; so that with them the result is the same as in Chaveau's experiments on *Bacilli* at a normal pressure, if a suitable temperature is retained—say 35°–38°; for then the virulence of the poison is more pronounced than when the cultivation is undertaken with a thick layer. If, on the other hand, a high temperature, 42°–45°, is brought to bear on thin layers subjected to great pressure, the bacilli in them become almost inoffensive. The author applies the epithet of *eugénésique* to the lower and of *dysgénésique* to the higher temperatures just mentioned.

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* See this Journal, iii. (1883) p. 688.

† Fortschritte der Medicin, i. (1883) p. 609. See Bot. Centralbl., xvi. (1883) p. 305.

‡ Comptes Rendus, xcviii. (1884) pp. 314–7.

**Bacteria in the Human Amnion.**[*]—Trinchese describes in a brief note *Bacteria* discovered on the internal surface of the amnion of a fœtus extruded after the third month of gestation. The perfect freshness of the membrane made it impossible to explain the presence of these germs as being due to incipient putrefaction; and, on the other hand, it was equally certain that the mother was not suffering from any infectious disease. The epithelial cells of the amnion were quite unaltered, except that the nucleus contained a large cavity filled with liquid, in which were a great number of *Bacteria*; the nuclear substance itself was pressed to one side, and had assumed a crescent-like form. In all other respects the tissues were quite normal.

A fuller account of this interesting phenomenon is promised shortly, and the present note is published to stimulate inquiries into the causes of abortion; it is possible that the presence of microphytes may have a great deal to do with it.

**Bacillus of "Rouget."**[†]—Pasteur and Thuillier show that the bacillus of "rouget," as found in pigs, can be attenuated by passing it through rabbits. The inoculated rabbits are all rendered very ill or die, but pigs inoculated with the bacillus after the virus has been passed through a series of rabbits have "rouget" in a mild form, and enjoy immunity from further attacks. A series of inoculations carried through pigeons, on the other hand, increases the virulence of the disease when a pig is inoculated from the last of the pigeons.

**Living Bacilli in the Cells of Vallisneria.**[‡]—T. S. Ralph records the presence of these organisms, and states that there is a little difficulty attending the demonstration, but that if the following directions are carried out with other water-plants, he believes they will be seen in those cases also.[§]

A thin section of the cuticle of the leaf of *Vallisneria* should be sliced off, and placed on a slide, with the cuticular surface next the cover, and then the slide should be placed on a rest, with the cover downwards or towards the table, and remain there for five minutes at least, in order to allow the organisms to fall on to the cuticular walls of the cells, and then examined under a 1/4 in. objective. They must be looked for in the quadrate cells, and will be seen moving about the chlorophyll-grains, even when cyclosis may be going on; and after the lapse of some minutes they will gravitate out of sight, or be found heaped together at the lower end of the cell (or apparent upper end). It is this circumstance which has prevented any recognition of their presence in the plant. They are rarely, if ever, seen in the long, deep-seated cells, which exhibit cyclosis so well in this plant.

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[*] Atti R. Accad. Lincei, vii. (1883) p. 237.

[†] Comptes Rendus, xcvii. (1883) pp. 1163–9.

[‡] Journ. of Microscopy, iii. (1884) pp. 17–8.

[§] He has since found them in *Anacharis*. See Proc. Roy. Soc. Victoria, 10th May, 1883.

**Simulation of the Tubercular Bacillus by Crystalline Forms.**[*]—The memoirs of A. Celli and G. Guarnieri give the results of a large number of observations on the bacillus described by Koch in the nodules of tuberculosis, and in the sputa of consumptive patients, and further call attention to certain crystals found not uncommonly in these sputa, which, both by their appearance and by their behaviour towards anilin colours, imitate the tubercular bacilli. The microscopic differences between the two classes of objects are minutely described.

**Cultivation of Bacteria.**[†]—Dr. E. Klein has been able to avoid the drying-up which mars Koch's method of growing bacteria on a gelatine fluid film in a moist chamber, by using instead of the latter a cell closed with a cover-glass, to which was sometimes attached a thin glass tube, leading into it, and plugged with cotton wool. The cultivating fluid used is composed of one part of so-called "gold-label gelatine" cut into strips and soaked for a night in cold-water, and then dissolved, just neutralized with carbonate of soda, and filtered while hot, and three parts of pork broth; all the materials are prepared with a view to their perfect sterility by heat and insulation of the air involved by cotton-wool. To the lower side of the cover-glass of the cell is applied a drop of cultivating fluid, which is then allowed to solidify; after this it may be inoculated with the particular bacterium required by dipping a needle which has been heated, or a capillary tube which has been freshly drawn out, into the fluid containing the organism, and then drawing its point once or twice over the charged surface of the cover-glass. The progress of growth may be watched with the Microscope through the cover-glass; thus also the species of the organism thus introduced can be verified, and accidental contamination detected.

**Reduction of Nitrates by Ferments.**[‡]—According to A. Springer, the roots of plants are covered with small organisms which reduce nitrates, with evolution of nitric oxide. This ferment closely resembles the butyric ferment, and is probably identical with the *Microzyma cretæ* of Bechamp. It is composed of small cylindrical rods rounded at the extremities, generally isolated, but sometimes joined two by two. They move rapidly with a wriggling motion, and often bend their bodies until they form a perfect circle. Another ferment, or modification, is somewhat smaller, and spins round its smaller diameter as an axis. Phenol has no appreciable action on the new ferment. Similar results have been obtained since the author first announced his results, by Gayon and Dupetit, and Déhérain and Maquenne.

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[*] Atti R. Accad. Lincei—Transunti, vii. (1883) p. 282.

[†] 11th Ann. Report Local Government Board, 1882, pp. 177–8.

[‡] Amer. Chem. Journ., iv. (1883) pp. 452–3. See Journ. Chem. Soc.—Abstr., xlvi. (1884) pp. 350–1.

## Algæ.

**Rabenhorst's Cryptogamic Flora of Germany (Algæ).**[*]—Parts 6 and 7 of Dr. Hauck's 'Marine Algæ,' in Rabenhorst's 'Cryptogamic Flora of Germany, Austria, and Switzerland,' complete the account of the Florideæ with the Corallinaceæ, and commence the Phæophyceæ, which he divides into three orders, the Fucoideæ, Dictyotaceæ, and Phæozoosporeæ. The small number of species comprised in the first two orders are described, and the Phæozoosporeæ commenced. The families included are the Ectocarpaceæ (including *Sphacelaria*), Mesoglœaceæ, Punctariaceæ, Arthrocladiaceæ (the single genus *Arthrocladia*), and a commencement of the Sporochnaceæ.

**Distribution of Seaweeds.**[†]—A. Piccone gives a number of details with respect to the mode of life and distribution of marine algæ. As a rule, they are entirely confined to the coasts; although shells of diatoms are found abundantly at great depths, it is doubtful whether they have lived there, or whether the shells have been carried by currents. The gulf-weed the author thinks does really vegetate in the depths of the "sargasso-sea."

The physical nature of the sea-bottom, whether stony, sandy, or muddy, exercises considerable influence on the distribution of seaweeds, as also on their external form, and especially on their mode of attachment. Of this the author distinguishes three kinds:—attachment-disks, which occur only where the bottom is rocky or stony; a tow-like decomposed base and root-fibres; and a pseudo-parasitism on other algæ. Seeing that algæ derive no nourishment from their substratum, its chemical nature is indifferent.

As regards the purity of the water, a medium quality appears to be most favourable to the growth of seaweeds. A considerable influence is exerted by the varying density at different depths; and, as with land-plants, each species has its optimum temperature. The presence of light is indispensable to their growth; but it entirely ceases only with the absence of the chemical rays. Direct sunlight is more favourable to the growth of green, shade to that of red or brown algæ. Light has also an influence on the production and movement of zoospores, and on the heliophobic tendency shown by many fertilized ova.

Only those algæ which grow in shallow localities follow the movements of waves, and various species establish themselves in protected spots or those exposed to the surf, or according to the nature of the bottom. A great flow and ebb of tide is unfavourable for marine vegetation. The influence of marine currents is very great on the distribution of species.

The dissemination of spores is brought about chiefly by marine currents; but the author believes that their unequal specific gravity is not without importance in this respect. It is probable that they are also transported by fish, attached externally, or even after having been swallowed.

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[*] Rabenhorst, L., 'Kryptogamen-Flora von Deutschland, Oesterreich u. d. Schweiz. 2^ter Band, Die Meeresalgen von F. Hauck, Lief. 6–7.'

[†] Chron. Lic. Christ. Colombo, 1883. See Bot. Centralbl., xvi. (1883) p. 289.

On the retention of the power of germination by the spores of algæ very little is known; but it is probable that they differ greatly in this respect.

The colour of seaweeds is probably of considerable physiological importance. It is possible it may act like the colour of flowers, as an attraction to those marine animals which assist in fertilization, and also as a protection against those which are injurious. The same purpose may also be served by the different taste and smell of different species.

**Cystoseiræ of the Gulf of Naples.***—R. Valiante publishes a monograph of this genus. His investigations relate to the histology of the alga and the classification of the species. The points specially described are: The germination of the spores and formation of the embryo; the development of the vegetative organs of the embryo; the rhizoid processes, and radical disk; and the sexual organs of reproduction. In the systematic part eleven species are described, one of them new.

**Polysiphonia.**†—L. Kolderup-Rosenwinge has investigated the structure of this genus of seaweeds, especially the species *fastigiata*, *nigrescens*, and *violacea*. He confirms the statement of Schmitz that cell-division does not take place either by a transverse septum or by a longitudinal septum which includes the longer axis. The divisions of the common basal cell of "branch" and "leaf" in *P. violacea* were especially followed out and described. A peculiarity of the cell-division in *Polysiphonia* and in some other Florideæ is that the two daughter-cells are of unequal size. It usually gives the impression as if a smaller cell were cut off from a larger one, which remains more or less entirely unchanged. The spiral arrangement of the "leaves" is indicated already in the divisions of the apical cell. The formation of the "branches" takes place in different ways in the different species, pseudo-dichotomous, monopodial, or axillary.

The antheridia and cystocarps are the result of metamorphosis of the "leaves." The following is the mode of formation of the tetraspores in *P. fastigiata*. A large cell is first of all separated from one side of the parent-cell. This divides into three cells by two oblique, vertical, but not radial walls; two of them on the outer side, which behave like pericentral cells, a larger one on the inner side, which is again divided by a horizontal wall into two cells, the upper of which is the mother-cell of the tetraspores.

**Pithophora.**‡—F. Wolle records the interesting fact of the discovery in several localities in New Jersey, U.S.A., of this singular alga, hitherto known only in the tanks in the hot-houses at Kew, and made, by its discoverer Dr. Wittrock, the type of a new order allied to Confervaceæ.

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* Fauna u. Flora des Golfes v. Neapel. vii. Monographie, 1883. Die Cystoseiren, 30 pp. (15 pls.).

† Bot. Gesell. Stockholm, Sept. 16, 1883. See Bot. Centralbl., xvi. (1883) pp. 222-4.

‡ Bull. Torrey Bot. Club, x. (1883) p. 13.

**Resting-spores of Algæ.***—N. Wille describes the mode of formation of the non-sexual reproductive cells, commonly known as resting-spores, in a number of filamentous algæ, as *Trentepohlia* (*Gongrosira*) *de Baryana*, *Conferva pachyderma*, *C. stagnorum*, *C. Wittrockii*, *C. bombycina*, *Ulothrix Pringsheimii*, &c. All these cases agree in the reproductive cells thus formed being immotile, not produced by any sexual process, and not resulting from swarm-cells that have come to rest. They may, however, be divided into two classes, those produced without any special cell-formation, as in the cases of *Ulothrix*, *Conferva pachyderma*, and *Trentepohlia*, or after special cell-formation, as in *Conferva stagnorum*, *C. Wittrockii*, *C. bombycina*, and *Pithophora*. The former kind the author proposes to call *Akinetes*, the latter *Aplanospores*. Both kinds vary in this respect, that they may germinate immediately after their formation, or only after a period of rest. In the former case they perform the function of zoospores, i. e. increasing the number of individuals; in the latter case they act like zygotes.

In *Conferva*, *Ulothrix*, and *Œdogonium*, the mode of formation of the resting-cells resembles that in the Conjugatæ. The membranes of the filament become thicker, and incrusted with iron and lime; as soon as the separate cells again begin to grow, the outer dead layer bursts, and the form arises described earlier as a distinct genus under the name *Psichohormium*. In *Conferva pachyderma*, the akinetes are formed by a stronger deposition of cellulose in the inner cell-wall layer, while the outer ones become mucilaginous, and the separate cells are thus set free. The step to the formation of aplanospores in *C. stagnorum* and *Wittrockii* is a very short one. In *Cladophora fracta* single cells at the ends of filaments often swell up in the autumn, and become thicker walled and fuller of protoplasm. These hibernate, filaments with thin-walled cells springing from them in the spring. A similar process takes place in *Conferva bombycina* and in *Pithophora*. In *Trentepohlia de Baryana* two kinds of akinetes are formed.

No exact boundary line can always be drawn between akinetes and ordinary vegetative cells; aplanospores differ more widely from the latter, but pass insensibly into the former. The author's view is that these structures are formed whenever the conditions are unfavourable for the formation of zoospores or for a sexual mode of reproduction. Where they are abundantly produced, it is usual for the formation of zoospores to be rare. This is the case in *Conferva stagnorum* and *Cladophora fracta*, while in *Conferva pachyderma*, *Wittrockii*, and *bombycina*, *Ulothrix Pringsheimii*, and *Pithophora* they are at present unknown; in most species of *Cladophora* they are abundant. In *Trentepohlia umbrina*, quantities of swarm-cells are formed, but they rarely either conjugate or germinate; in *T. de Baryana* they are also formed, but soon perish, reproduction taking place by means of akinetes.

The author regards the resting-cells as affording good characters for the determination of species, and even in some cases of genera, but not of the larger groups, since their formation probably depends on external conditions.

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* Bot. Gesell. Stockholm, Sept. 26, 1883. See Bot. Centralbl., xvi. (1883) pp. 215–9.

**Hybridism in the Conjugatæ.**[*]—C. E. Bessey describes an interesting case of hybridism between two species of *Spirogyra*, *S. majuscula* and *protecta*. A perfect zygospore was found, resembling most nearly those of the latter species.

**New Genera of Chroococcaceæ and Palmellaceæ.**[†]—In an account of the algæ of Sweden, G. Lagerheim describes as many as sixty species new to that country; and gives also the following diagnosis of new genera:—

*Gleochæte* (Chroococcaceæ). Cellulæ globosæ vel subovales, binæ vel quaternæ in muco communi homogeneo vel indistinctissime lamelloso inclusæ, utraque seto longissimo instructa. Cytioplasma æruginео-cærulea, subgranulosa. Divisio cellularum in duas directiones. One species, *G. Wittrockiana*, possibly identical with *Chætococcus hyalinus* Kütz.

*Acanthococcus* (Palmellaceæ). Cellulæ adultæ globosæ vel subglobosæ, aculeis præditæ. Divisio succedanea, multitudo cellularum filialium globosarum, non aculeatarum, in cellula matricali provenit, quæ, membrana cellulæ matricalis in mucum conversa, liberæ fiunt. Cellulæ perdurantes oleosæ. Two species, one of them the *Palmella hirta* and *Pleurococcus vestitus* of Reinsch.

*Dactylothece* (Palmellaceæ). Cellulæ cylindricæ vel oblongæ, rectæ vel leviter curvatæ, utroque fine rotundatæ, singulæ-quaternæ in familiis consociatæ, tegumentis vesiculiformibus inclusæ. Familiæ numerosæ hoc modo formatæ stratum viride uliginosum formant. Divisio cellularum in unam directionem fit. Cytioplasma viridis. Zoosporæ ignotæ. Analogous to *Glæothece* among Chroococcaceæ. One species, *D. Braunii*, in greenhouses.

Also the subgenus *Holopedium*:—Merismopedium familiis forma irregulari e cellulis irregulariter dispositis compositis. Divisio cellularum irregularis. Includes the three species of *Merismopedium*, *irregulare*, *sabulicolum*, and *geminatum*.

**Chroolepus umbrinum.**[‡]—J. B. Schnetzler finds this alga, associated with a number of others, on the bark of the vine, forming moniliform threads of globular cells about 30 $\mu$ in diameter. It also occurs in similar localities imbedded in the thallus of a lichen belonging to the genus *Pyrenula*. In this condition it forms filaments composed of much smaller cells. When the lichen-thallus decays, these cells escape, and, on multiplying, assume again the normal size of those of the free form.

**Constant Production of Oxygen by the Action of Sunlight on Protococcus pluvialis.**[§]—In the summer, *Zygnema* and *Conferva* may frequently be seen borne to the surface of pools of stagnant water by innumerable minute bubbles of oxygen gas. Some of the simplest of the unicellular algæ, e. g. *Protococcus pluvialis* and *P. palustris*, exhibit this peculiarity to a remarkable degree. T. L. Phipson has cultivated some of the last-mentioned plants by exposing pump-water to air and light for some weeks, and as soon as good growth was obtained, small dead branches of poplar were put in the water; the *Protococcus* developed rapidly upon them. The branches can then be put in flasks full of water, and the production of oxygen observed; this takes place immediately the flasks are exposed to the sun's rays; the oxygen comes off in the minutest bubbles, but in such great numbers as to form a froth on the surface; in some higher plants, e. g. *Achillea Millefolium*, the gas collects at the end of the leaves, and comes to the surface in large bubbles. If the flask is inverted the evolution of gas continues for about three days; the introduction of a minute quantity of caustic soda stops it on the first day by depriving the plant of carbonic anhydride. On renewing the water after three days, the evolution recommences, and so by keeping up a constant supply of pump-water and the production of oxygen, may be kept up to all appearance indefinitely.

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[*] Amer. Natural., xviii. (1884) pp. 67–8.

[†] Oefvers. af Svenska Vetensk. Akad. Förhandl., 1883, pp. 37–78 (1 pl.).

[‡] Bull. Soc. Vaud. Sci. Nat., xix. (1883) pp. 53–4.

[§] Chem. News, xlviii. (1883) pp. 205–6.

The author has devised a simple apparatus for this purpose. A wide-mouthed bottle with tubulure near the bottom, is fitted with a gas delivery tube, and a tube with tap connected with a water-supply; the water must neither be boiled nor distilled, nor must it be in the slightest degree alkaline. A tap is put in the tubulure and is used to empty the bottle. Some of the poplar branches are placed in the bottle, water is run in, and the bottle exposed to sunlight; the oxygen can be collected in a gas-holder. After three days the old water is run out of the bottle and fresh water run in. The author suggests that by employing graduated vessels, &c., the apparatus might be used as an actinometer. The gas produced contains about 98 per cent. oxygen. The author remarks incidentally that carbonic anhydride in presence of sunlight is not decomposed by plants, but simply absorbed, water and hydrogen dioxide being equally essential for the production of oxygen, and the gas being evolved from the tissue as a consequence of the absorption.

**Chromatophores of Marine Diatoms.***—O. Müller describes the peculiar form and structure of the chromatophores in some marine diatoms, hardened and coloured according to Pfitzer's nigrosin-picric-acid method.

In *Pleurosigma angulatum* the chromatophores consist of two very long bands, twice the length of the longitudinal diameter of the cell or more, comparatively narrow, much lobed and indented, but never perforated. They are arranged symmetrically on each side of the cell. For their whole length their surface is applied to the cell-wall, and separated from it by only a thin layer of protoplasm. A middle portion of each band, about one-third of its entire length, runs undivided to the inner surface of the upper shell—i. e. the shell which contains the central portion of the chromatophore. Two pieces, together about equal in length to each of the middle pieces, lie separately on the lower shell, while the ends which enter the apices of the cell turn to the girdle-bands of the cell-wall, where also the pieces which start from the upper and under shells unite. The function of the chromatophore is therefore distributed nearly equally to both sides of the protoplasmic body of the cell. The median line of the chromatophore coincides, as in *Navicula*, with that of the girdle-bands; but the portions which project upon the adjoining cells are not arranged symmetrically in relation to the plane of division. The middle piece of each chromatophore, which lies on the upper shell, on both sides of the raphe, incloses, in the typical arrangement, the central cell-nucleus with a semicircular opening inwards.

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* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 478–84.

*Pleurosigma balticum* also contains two chromatophores whose median line coincides with that of the girdle-bands, and which project on the shells on both sides; but they are not band-shaped and folded, as in *Pleurosigma angulatum*, but plates of a somewhat complicated structure. *Pleurosigma Hippocampus* has chromatophores of a similar form, but narrower.

*Nitzschia Sigma* has only a single chromatophore, which is, however, completely divided by the cell-nucleus; not so completely in other species belonging to the same group of the genus. It is plate-shaped, and is applied to that girdle-band which is opposite the two points of the keel. On its median line, in each of the two halves, lie five or more round or oval pyrenoids, bodies which are not unfrequently present in diatoms. They appear here not to be of such simple structure as in other cases. They are coloured more or less dark by nigrosin, and are surrounded by a light border, which, with very high powers, exhibits a differentiation into small bright dots, the structure being therefore similar to that in the Chlorophyceæ.

**Division of Synedra Ulna.***—G. Schaarschmidt has found this diatom in an active state of division; he fixed the specimens with picric acid or absolute alcohol, coloured them with hæmatoxylin or eosin, compared them with living specimens, and gives the following as the chief results obtained. When division commences the breadth increases by the girdle-bands becoming separated to a greater distance; but the lamellæ of endochrome retain their position, and their margins scarcely project in this condition over the girdle-bands; while, in individuals that are not dividing or only preparing to divide, they reach the end of the cells; but in those which have just divided or are dividing repeatedly, they are about 1/6 of the length of the cell shorter than the shell. The strongly refractive colourless nucleus is in the central mass of protoplasm which often lies only on one shell; no nucleoli can be detected in it. In cells which are about to divide it moves into the middle of the cell; its enveloping protoplasm, through which small mucilaginous particles are scattered, then lengthens towards the ends of the cell, where the protoplasm then takes the form of an axile band uniting the ends of the cell, and concealing the nucleus in its swollen central part, which no longer touches the shells; the nucleus is now held by delicate threads of protoplasm which spring from the plates of endochrome.

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* Magy. Növ. Lapok, vii. (1883) pp. 49–58 (1 pl.). See Bot. Centralbl., xvi. (1883) pp. 198–9.

While the axile band is developing thus, the plates of endochrome broaden to such an extent that they almost cover the entire sides of the girdle-bands. At this period, or even earlier, the plates, which were at first constricted, are now bisected.

At this stage of development the division of the nucleus commences. The species under examination exhibits this peculiarity, that the division of the nucleus, which now becomes of a broadly elliptical form, and breaks up immediately into two daughter-cells, proceeds in a direction parallel to the new shells. Only in a few cases are there spindle-fibres stretched between the two daughter-nuclei; these fibres are knotted in the middle, which may be regarded as a tendency towards the formation of nuclear plates. The daughter-nuclei may divide again, so that in the middle of the axile band there are formed at length from four to seven nuclei.

When the division of the nuclei is complete, the substance of the axile band becomes firmer, commencing at the ends, and dark dots are seen in it arranged in longitudinal rows, and later, short transverse striæ corresponding to them, which, however, become gradually indistinguishable towards the centre of the band where the nuclei lie. The daughter-nuclei, which hitherto lay one over the other, now approach one another in a horizontal direction (in the transverse diameter of the cell), and are separated only by the axile band, which is continually becoming denser, and which now divides the cell into two halves as an extremely delicate and flexible septum. The new septum becomes further differentiated, splits, and from it are formed the new shells of the daughter-cells. This process goes on very rapidly, and the transitional steps can be readily followed from the simply punctated or striated lamellæ to the double lamellæ. Cells with split septum are more often met with than with simple septum; but still more often the septum shows the dots only at the ends. These dots or striæ—since the septum is turned with its narrower side towards the observer—probably correspond to the channels of the new shells.

The new septum now acquires firmness, and now the movement commences of the lamellæ of endochrome; of those which lay upon the old shells, those which were opposed diagonally, with their ends pointing towards the middle of the cell, creep slowly through the sides of the girdle-bands, while the other lamella remains upon the old shell, pushing itself beneath it. Delicate threads of protoplasm are not unfrequently found between the upper ends of the lamellæ and the ends of the cell. The lamellæ attain their full size very quickly after their transfer. Frequently they break up into two, three, or more pieces, which become transported in the same way as the larger ones.

The nuclei may break up in the same way by repeated constriction into a large number of daughter-nuclei; four or five nuclei are not unfrequently found in each daughter-cell. The cells of *Synedra Ulni* are therefore multinucleated during and after division.

**Arctic Diatoms.***—P. T. Cleve describes the diatoms collected by M. Kjellman during the expedition of the 'Vega' from the following sources:—Arctic diatoms from the ice near Cape Wankarema and near East Cape; from the surface in Behring's Sea; fresh-water diatoms from Japan; diatoms from algæ collected on the island of Labuan, near Borneo; from algæ and coarse bottom-mud collected near Point de Galle, Ceylon; and from bottom-mud between Aden and Bab-el-Mandeb. The Arctic material contained a very large number of species, which varied to an astonishing extent, so that in many cases it was scarcely possible to trace out the limits of the species. On the other hand, samples from the bottom of the North Siberian Sea were quite free from diatoms. The descriptions, &c., are in English, and several new species are described.

A few new species are also described by the same authority,† collected during the Arctic expedition of Sir George Nares.

**Pelagic Diatoms of the Baltic.**‡—A. Engler describes the pelagic diatoms gathered in the Baltic, chiefly in scum on the surface of the water in the bay and harbour of Kiel. Different times of the year are distinguished by the appearance of different genera and species. Among the more interesting forms observed was the remarkable genus *Chætoceros*, provided with horns or bristles from 5 to 20 times the length of the cylindrical part of the cell, the cell-contents being in communication throughout. Of this genus many species are known in the Arctic and Pacific Oceans; six are now described from Kiel Bay, one of them, *C. Grunowii*, new, was found with spores.

**Diatoms of Lake Bracciano.**§—M. Lanzi has examined for diatoms the water from the middle of this lake, and finds that, like the pelagic species, they differ from those found in shallow water. The swimming deep-water species found were *Fragilaria crotonensis* Edw. (*Nitzschia Pecten* Brun.), *Cyclotella comta* var. *oligactis* Grun., *C. comensis* Grun., and *Asterionella formosa* Hass. Those found near the shore, living on plants, stones, &c., belonged to the genera *Navicula*, *Stauroneis*, *Mastogloia*, *Cymbella*, *Amphora*, *Cocconeis*, *Achnanthes*, *Gomphonema*, *Staurosira*, *Synedra*, *Epithemia*, *Surirella*, *Cymatopleura*, &c.

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* Cleve, P. T., 'Diatoms collected during the expedition of the *Vega*,' 60 pp. (4 pls.), Stockholm, 1883.

† Journ. Linn. Soc. (Bot.), xx. (1883) pp. 313–7.

‡ Ber. Deutsch. Bot. Gesell., i. (1883); Gen.-Versamml. in Freiburg, pp. x.–xiii.

§ Atti Accad. Pont. Nuovi Lincei, xxxv. (1883) May 21. See Bot. Centralbl., xvi. (1883) p. 257.

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## MICROSCOPY.

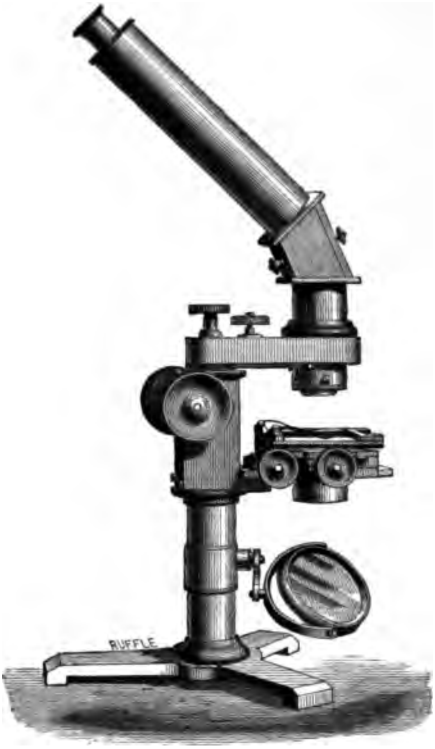
### a. Instruments, Accessories, &c.

**Ahrens's Erecting Microscope.**—In this instrument (fig. 28), by Mr. C. D. Ahrens, the erecting prism is inserted below the body-tube, and the latter is inclined at an angle of about 45°.

The prism is similar to Nachet's erecting prism.

When the Microscope has a fine adjustment, the prism is mounted on a piece of tube, as shown in the woodcut; but when the fine adjustment is omitted, as in the smaller forms, the prism is fixed directly on the arm.

Fig. 28.



For convenience of packing, the inclined body-tube slides off, and a cap is fitted over the top of the prism-box.

The advantages claimed by Mr. Ahrens for the instrument are the erection of the image by a prism at the lower end of the body-tube immediately over the objective instead of over the eye-piece, "so that any objective and any eye-piece can be used without any trouble," and the convenient inclination of the tube.

**Bulloch's Improved "Biological" Microscope.***—Mr. Bulloch has made further improvements in his "Biological Microscope," principally in the substage.

The substage and mirror-bars move independently, with the object as a centre, as heretofore; but immediately beneath the stage, just above where the rackwork ends, the substage-bar is cut transversely and the two parts joined together by a pinion and screw passing vertically through lateral projections cast for the purpose. About this pin the lower part, carrying the substage with its rack and centering screws, swings laterally, entirely out from beneath the stage. The space between stage and mirror is thus unobstructed by the substage, and the substage itself is practically clear of the Microscope, where it can be seen, and apparatus removed from or added to it with even more facility than if it were held in the hand.

Mr. Hitchcock regards it "as the greatest improvement in substage fitting that has been made for years, and one that is sure to be appreciated as its value becomes known."

The substage-ring is also made in two parts, and the lower part swings to one side independently. This part may carry a tinted glass to modify the light, or the diaphragms of a condenser, which could be conveniently changed. It would be better to place the condenser and its diaphragms in the upper substage-ring, while the polarizer with its plates of mica and selenite are fitted in the lower ring. Such an arrangement would give the microscopist every facility for work that could be desired. Without removing a single accessory, he would be prepared to use the light directly from the mirror by turning the substage aside. Then the condenser could be brought into use by a single motion, and the different effects of oblique light and dark-ground illumination obtained by the simplest possible operation of changing diaphragms. By bringing in the polarizer, which is always ready for use, all the effects of polarized light can be obtained.

**Cox's Microscope with Concentric Movements.†**—The Hon. J. D. Cox describes the new features of this stand (fig. 29) to consist in "the construction of the arm of the instrument in the form of the segment of a circle in which is a circular groove or slot; the pillars of the base have on their inner faces tongues which fit the slot in the arm. The inclination of the instrument is made by the sliding of the whole body along the fixed tongues in the pillars of the base; the centre of motion of the whole body is also the optical centre of the instrument, around which the stage, the substage bar, and the mirror bar all revolve. The body is clamped up in any position by the set-screw, with large milled head, in the base. The result is a shifting of the centre of gravity in changing the inclination of the instrument, so that great stability in all positions is secured, and the optical centre is thus made the centre of all the circular motions of the parts of the instrument.

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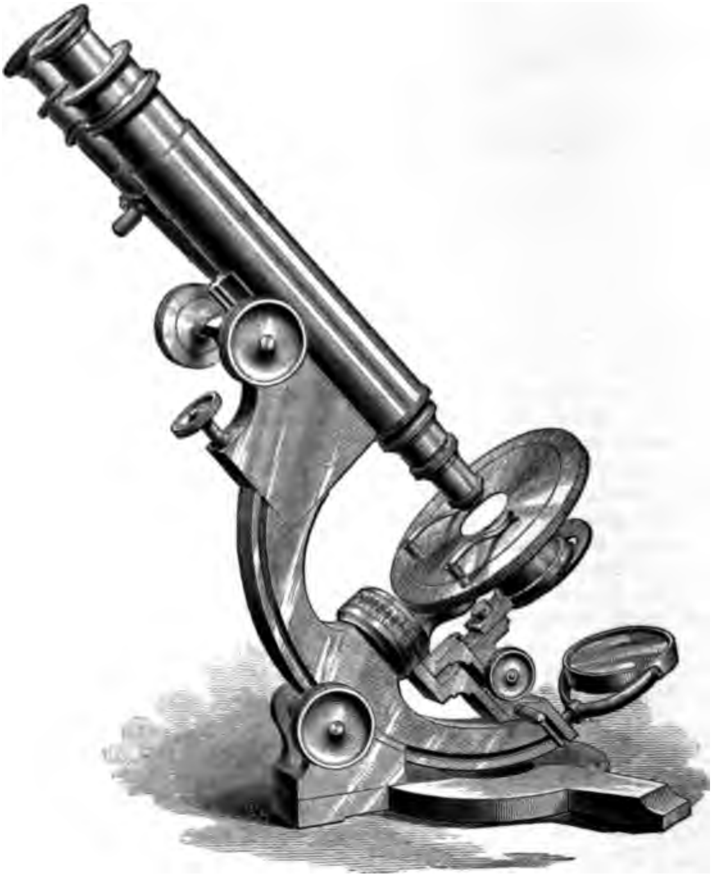
* Amer. Mon. Micr. Journ., v. (1884) pp. 9-10.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 147-8 (1 fig.).

The first application of the sliding motion of the body was made by Geo. Wale in his 'Working Model,' but he did not make the centre of motion the optical centre of the instrument. Mr. Wenham in his elaborate concentric Microscope uses a separate rocker arm with the whole body of the ordinary instrument pivoted above it. My design, which has been constructed by the Bausch and Lomb Optical Company, greatly simplifies the Wenham instrument, and extends the principle contained in Wale's, and makes a very compact,

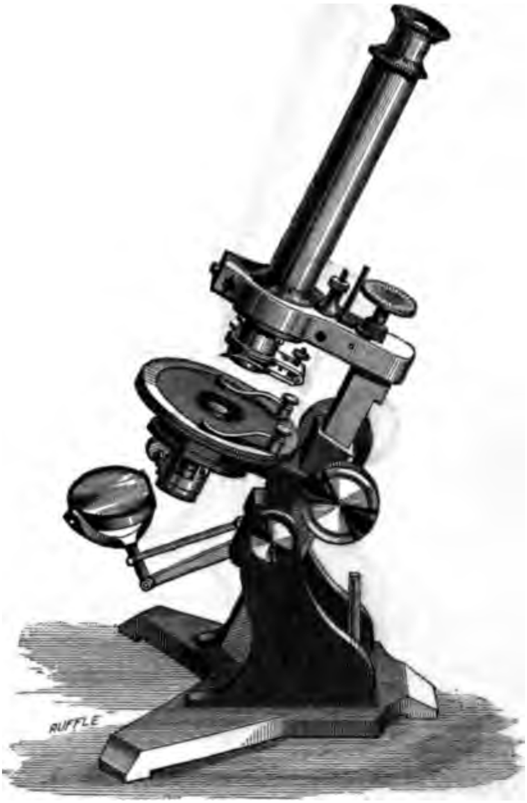
FIG. 29.



stable, and satisfactory stand. The radius of the circular motion is 4½ in., the stage is 4½ in. in diameter, the concave mirror has 4½ in. focal length, and the diameter of the mirror may be from 2½ to 3 in."

**Geneva Company's Microscope.**—This instrument (fig. 30), made by the "Société Genevoise pour la Construction d'Instruments de Physique," has two specialities; one being the spring pincers for rapidly inserting the objective, described *infra* p. 284, and the other the mounting of the mirror.

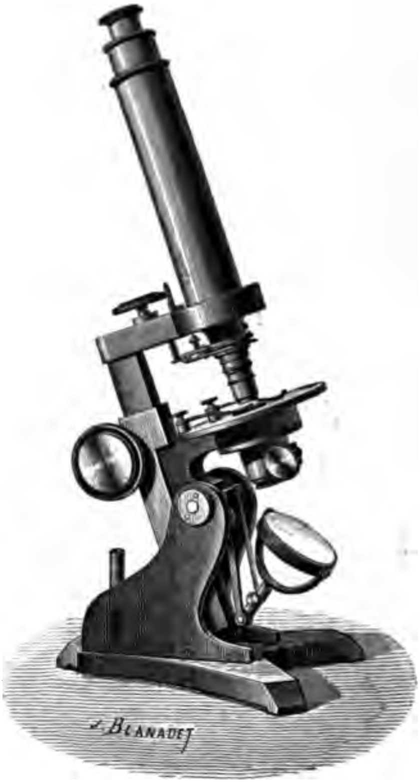
FIG. 30.



The mirror is attached, as shown in the woodcut, to three arms articulated in such a way that "the centre of the mirror is made to describe a curved line very nearly an arc of a circle, the centre of which is on the object under examination. The most suitable illumination is thus obtained very rapidly, the observer not having to regulate at the same time the focal distance of the mirror and its lateral distance from the axis of the Microscope."

The condenser fits into a double cylindrical tube beneath the stage, the inner tube being moved up or down in the outer by rack and pinion. The diaphragms are also inserted in the inner tube. The whole arrangement can be readily turned away from the axis on an excentric pivot.

FIG. 31.



The stand, in its general form, size (16 in. high), and workmanship, is one of the best that we have received from the Continent.

[Since fig. 30 was cut, the Geneva Company have supplied us with fig. 31, which shows more of the mode of attachment of the arms of the mirror.]

**"Giant Electric Microscope."**—This Microscope (*ante*, p. 109) has continued to be the subject of somewhat ludicrous comments on the part of the newspaper press.

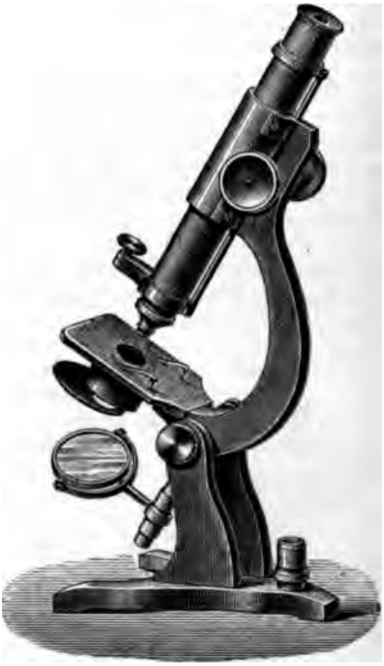
The one point of remark is the extent of the magnification

(4,000,000 times), even the *Times* (28th January) signalling specially the fact that the "eye of the smallest sewing needle made appears to be about 6 feet long by 4 feet wide, the needle itself appearing to be about 20 feet thick. *From this it will be judged how well the minutest details in the minutest specimens are brought out*" (!)

Most of the writers are not content to limit the value of such an instrument to the display of objects to large audiences, where the inferiority of the display is to some extent compensated for by the increased number of spectators who can see the objects at the same time, but evidently suppose that the increase of the magnification represents a proportionate increase in the scientific value and capacity of the instrument, and that by the use of "Giant Electric" Microscopes we are brought many degrees nearer to the vision of the ultimate molecules of matter than we are when sitting at home with a student's Microscope only.

The *Standard* of 28th January says, "But although this great Microscope can make the eye of the smallest sewing needle apparently a huge orifice some seven feet by five in dimensions, yet the component particles of the tissues of either animal or vegetable organisms cannot be *even yet* made visible, and the minute divisions of matter would remain unknown, so far as the sight is concerned, and would be an inscrutable mystery, except for the deep reasonings of the educated human mind;" while the *Norwood Review* asks "What assistance, for instance, may not surgeons derive from it in the study of nosology? It is safe to predict that Science in her onward march will find a valuable accessory in the "Giant Electric Microscope"!

FIG. 32.



**Tolles's Student's Microscope.**—Fig. 32 is given by Dr. L. Dippel in the latest edition of his 'Das Mikroskop' (p. 541) but without the explanation that it represents not a modern arrangement, but one of the earliest forms of Microscope devised by the late R. B. Tolles, the peculiarity of which was that the rack of the coarse adjustment was cut on a rod attached at both ends to the body-tube and passed through the straight part of the limb where the pinion acted upon it. We believe this plan was adopted for economy of manufacture, as the body-tube sliding in a socket required very little outlay in the matter of accurate bearings. It was, however, abandoned in favour of the usual Jackson slides and rack.

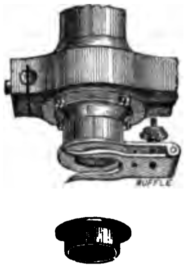
Another feature in the design of the stand, which we have found convenient in practice, was the greater bend of the limb than usual, by which the space above the stage was left free for manipulations with either hand. This latter feature has been maintained in all the later models of Microscopes issued by Mr. Tolles.

**Winter's, Harris's, or Rubergall's Revolver Microscopes.**—Mr. Harris of Great Russell Street, W.C., informs us that Thomas Winter was the "first and true inventor" of these instruments (described *ante*, pp 114–5) more than 56 years ago, when Mr. Harris inherited the business.

The one described as a simple Microscope bears the name of "T. Winter, No. 9, New Bond Street, London," while that figured at page 115 has, it appears, engraved on the cross arm carrying the body-tube, "Thomas Rubergall, Optician to H.R.H. the Duke of Clarence, 24, Coventry Street, London." Winter worked for Mr. Harris, and sold the first model to him (the simple form mentioned *ante*, pp. 114–5). Later Winter made some for Rubergall, probably the compound one (fig. 11). He also made some much smaller ones, which were sold for a few shillings.

**Geneva Co's. Nose-piece Adapters.**—This (fig. 33) consists of two pieces of brass hinged together at the back. The upper is immovably attached to the nose-piece of the Microscope; the lower terminates in a fork, which lies just under the nose-piece. The two plates are kept together by a set-screw, acting on a spiral spring, which can be tightened or loosened as required. The objectives are screwed to the collar shown in the fig., which slides in the fork. When the objective is centered with the optic axis, a slight projecting rim on the upper plate drops into the aperture of the adapter; the objective is then held fast, but is readily removed on applying a moderate downward pressure, which depresses the forked plate and enables the collar to be slipped out. By the set-screw the amount of pressure required to be applied can be varied.

FIG. 33.



The above form is a fixture on the Microscope, but the Company make another which is removable. It does not appear, however, to differ in principle from the nose-pieces of Nachet and Vérick (see this Journal, i. (1881) pp. 661–2).

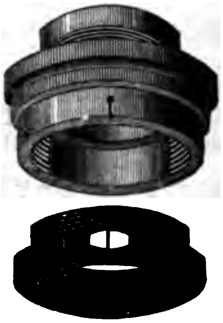
The advantages of such arrangements are explained by the Geneva Company to be (1) economy of time, (2) "a mechanical centering of the objective much more perfect than can be obtained with a screw, the defects of the centering being immediately recognized can be partly corrected, and (3) we can readily choose the side of the objective which gives the best images, when oblique illumination is used."

**Zentmayer's Nose-piece.**[*]—This (fig. 34) is yet another of the nose-pieces for rapidly changing objectives, so many of which have been brought out during the last few months.

Mr. Zentmayer's plan consists simply in the adoption of Mr. Nelson's form of adapter (see vol. ii. (1882) p. 858) with the inner screw-thread filed smooth in two opposite segments, but in place of altering the thread of the objective itself, he puts on it a separate collar, the inner thread of which is entire, but the outer thread filed smooth in two places in a similar way to that of the adapter.

Mr. Zentmayer thought it useless to adopt the original plan, "unless all the prominent manufacturers would agree to cut the screw-threads of objectives and nut in the same relation," which would be difficult to establish; but "by means of the collar he can manufacture a nose-piece and collar for any objective without having either at hand."

Fig. 34.



**Törnebohm's Universal Stage Indicator.**[†]—A. E. Törnebohm describes his arrangement as follows:—"Every petrological Microscope is now, as a rule, provided with a scale, or other arrangement on the stage, whereby we can readily find again any particular point in a preparation which it is desired to mark. According to the methods hitherto used, however, the contrivance which gives the position of a point in the preparation, is only available for a given Microscope, or at most for the Microscopes of a given maker. It would naturally be better if it were available for all petrological Microscopes, so that in sending away a preparation for inspection we could easily indicate the point to be observed without an ugly ring of ink. This advantage can be easily attained by the following simple contrivance, which I have adapted to my Microscope for years past and which I have found very effective.

The stage is divided by lines crossing at right angles, like a chess-board, the distance between the lines being exactly 2 mm. Every fifth line should be somewhat thicker so as to facilitate the counting. It is superfluous to mark the lines with figures. Two of the lines must cross each other *exactly* in the centre of the stage, and the counting starts from these. When I wish to mark a point in a preparation, I first adjust it in such a manner that the edges of the slide are parallel with the lines. I then determine the position of one corner (preferably the lower left corner) by counting from the two middle lines, and write the result, in the form of a fraction, upon the label of the preparation, as for example $\frac{113}{78}$ if the distance along the vertical edge (the writing on the preparation being horizontal) is found to be 11·3, and that along the horizontal edge 7·8. An estimate can be very well made within a tenth (that is to 0·2 mm.) which is sufficiently near. It may sometimes happen with large preparations and slides of ordinary size that the corner to be marked lies outside the divisions. I therefore mark the position of the opposite diagonal, and put an angle round the fraction thus: $\overline{\frac{106}{47}}\Big|$

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[*] Amer. Mon. Micr. Journ., v. (1884) pp. 42-3 (1 fig.).

[†] Neues Jahrb. f. Mineral. Geol. u. Paläont., 1883, i. pp. 195-6.

* * *

I have been able to convince myself by trials that divisions which are good for one Microscope are equally good for others similarly arranged, and that therefore the contrivance is a practical one."

**Stokes's Fish-trough.***—A. W. Stokes describes a simple apparatus for aërating living fish whilst under observation. It is shown in perspective at fig. 35, and in longitudinal section at fig. 36, *a*, *a* being two wedge-shaped slips of wood well soaked in paraffin wax to render them waterproof, *b*, *b*, two 3 × 1 glass slips, so arranged as to form, with the wood slips, a wedge-shaped glass box. The larger end of this box is inclosed in a short piece of indiarubber tube *c*, and this tube is closed by a cork. A short piece of glass *d* is fixed inside about midway between the glass sides of the box, so that it will form a shelf upon which the fish's tail may be during examination, as shown in fig. 36. At either end of the box are fitted two short glass tubes *e e*, which when the instrument is in use are respectively connected by indiarubber pipes with bottles at different levels, to obtain a circulation of water.

FIG. 35.

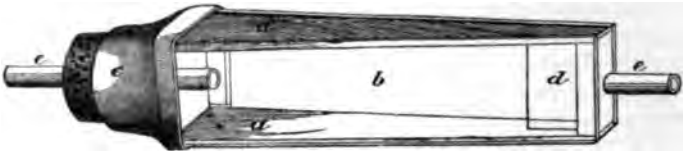
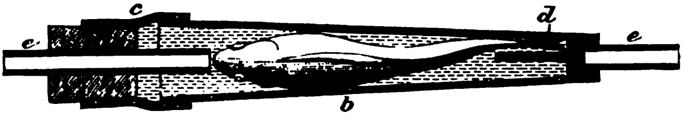


FIG. 36.



**Nelson-Mayall Lamp.**—At the Society's meeting in January, Mr. J. Mayall, jun., exhibited the modified form of Nelson's lamp,† shown in fig. 37. The modifications consist (1) in making the oil-well circular instead of square, so that the standard passes conveniently through the centre, and the well carrying the lamp can be rotated for purposes of centering, &c.; (2) a rackwork is applied to the standard by which the height of the lamp can be adjusted rapidly; (3) the base is made thinner and the fittings beneath the well altered so that the burner can be put 3/4 of an inch lower than formerly; (4) the oblong frame carrying the lamp-glass (an ordinary 3 × 1 slip) is provided with two extra grooves, in which may be slid 3 × 1 slips of tinted or ground glass, or a brass plate (shown in the fig.), to which an adjustable diaphragm is fitted, can be used in combination with white or tinted light; (5) the cylindrical part of the chimney is arranged so that an opal glass reflector may be inserted if desired. Whilst adding but little to the cost of the lamp as devised by Mr. Nelson, the new form combines several points of novelty suggested by practical experience.

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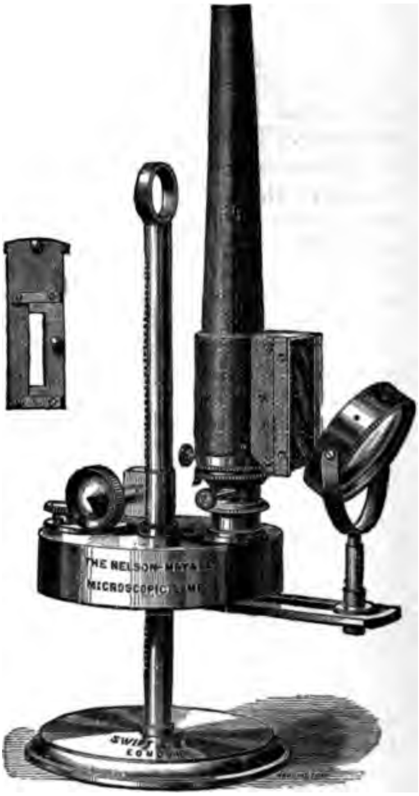
* Journ. Quek. Micr. Club, i. (1884) pp. 322–3 (2 figs.).

† See this Journal, *ante*, p. 125.

Fig. 37.



**Standard Micrometer Scale.*** — It will be remembered that the American Society of Microscopists ultimately abandoned their original micrometric unit of 1/100 mm. and adopted 1/1000 mm. or 1 $\mu$. The United States Bureau of Weights and Measures undertook to prepare and authenticate a standard scale, and in August 1882, such a scale, ruled on a platin-iridium bar, and verified with great care by Professor C. S. Pierce, was placed at the disposal of the National Committee on Micrometry representing the various Microscopical Societies. A sub-committee for testing this micrometer was appointed, on whose behalf Professor W. A. Rogers subjected the plate to a prolonged and elaborate study which was not completed until August 1883.

This scale is divided into ten millimetres, each division being marked by three lines distant from one another ten microns, and the measurement is to be made from the mean position of one triplet of lines to that of another. The first millimetre is again divided in the same manner into tenths of millimetres. The first tenth of a millimetre is subdivided into ten spaces of ten microns each. There are thirteen of these lines at the beginning of the centimetre, the first tenth of a millimetre being measured from the mean of the first three to the mean of the eleventh, twelfth, and thirteenth. The scale is engraved on a piece of platin-iridium made by Matthey, and containing 20 per cent. of iridium.

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* Proc. Amer. Soc. Micr., 6th Annual Meet., 1883, pp. 178–200.

Professor W. A. Rogers gives the results of a very elaborate "study" of the scale, which is now in the custody of the American Society of Microscopists, and available, under regulations, to "parties of eminent ability" for the comparison and verification of their standards. Three copies are to be made on glass, which will be lent out.

**Microscopic Test-Objects.***—The correspondence on this subject between "Monachus" and Mr. E. M. Nelson has been further continued, the former finally accepting (as "that which was to be demonstrated") Mr. Nelson's admission that when he wrote that he had by particular means made the discovery of the "true structure" of *Surirella gemma* he did not mean the "ultimate true structure."

There is one point however in the correspondence left untouched, which we refer to because the misapprehension which Mr. Nelson was under on the subject has at one time or another been widely shared and we have no doubt is so still.

If we have a grating (fig. 38) it will, as we know, give rise to diffraction spectra as in fig. 39. But if we stop off all the spectra except two nearest the central dioptric beam (say at the top and side) we shall still see the grating. Hence it has been supposed that only those spectra were really necessary for the image, or as Mr. Nelson puts it, "the true structure can be seen without taking up all the diffraction spectra."

FIG. 38.

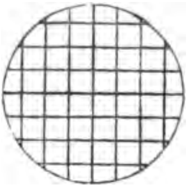
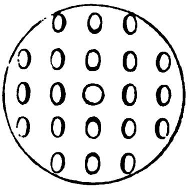


FIG. 39.



It cannot be too clearly borne in mind that this is an erroneous notion and that it is a fundamental point of the diffraction theory that if we are to see a true image of the object, *all* the diffraction spectra into which the original pencils were separated must be again gathered up and brought to the eye, so that wherever any of the diffraction spectra (up to the limit of vanishing intensity) are wanting, the image is incomplete. The absence of the spectra shut off may produce very considerable variations in the image, not only in the breadth of the lines and spaces, but otherwise.

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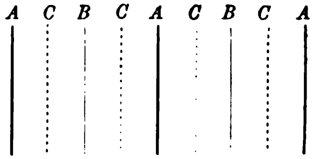
* See Bibliography, *infra*.

**Aperture and Resolution.***—L. Wright, while agreeing in the utter impossibility of ever knowing by absolute observation the "true structure" of minute objects, yet thinks there is something in the objections to overmuch dependence upon the results of very oblique light.

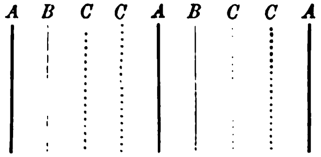
Let us suppose we have an object whose true structure is something like fig. 40, explained or described as follows:—

Fig. 40.



Let the black lines A A A denote strong ribs, or striations, or ridges 20,000 to the inch; B B lesser ridges midway between them, and C C C either valleys or fainter markings midway between these. A low-angled lens would show the black lines only; a good glass would bring out B B as well; a good immersion the faint dotted lines C C C. But even in this simple case these latter would certainly appear as lines; for the distances represented by the dots are far too minute for their spectra (transverse to the others) being included in any lens yet made. Let us, however, now suppose the real structure to be modified as in fig. 41, the second strongest markings B B being next

Fig. 41.



A A A, but C C C altogether absent, and not as here shown. The second lens would, in this case, show only a slight thickening or blurring of the coarser striation A A A; but the immersion objective might show nearly the same image as that given by the previous structure, since the narrow intervals A B, A B, A B, would give the same spectra as if the gaps C C C were filled up. It is true the wider distances B A, B A, B A would, by their own spectra, strengthen the B B lines; but the dotted lines C C C would be created, and appear to show structure which did not exist.

But no microscopic structure really consists of absolute *lines*, and hence this is a very small part of the complicated problem. If, as we have supposed, AAA are ridges, they will have some absolute breadth, and these dimensions really constitute a still more minute set of lines, whose spectra are far beyond the collecting power of our lenses. Hence the reason why real lines, like Nobert's test-bands, can be truly "resolved" or photographed, though microscopic objects cannot. Supposing the objective can resolve lines of 100,000 to the inch, all it is capable of showing in an *object* is, that something—*some* variation of structure—occurs at regular intervals of 100,000 to the inch. If this is so, it will be shown as lines; but it is perfectly obvious that very rarely can it *really be* mere lines. It will have form of some kind; and every minute variation in light and shade due to that form, constitutes an infinitely minute *set of distances*, which will all cause their own spectra, too distant, if not too faint, to be gathered in.

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* Engl. Mech., xxxviii. (1884) pp. 470-1 (2 figs.).

Error may arise in yet another way. Lord Rayleigh has shown mathematically, and partially proved experimentally (by gratings eaten out in gelatine) that if an optical grating be composed (instead of white and black lines) of equally transparent narrow stripes, whereof each alternate one retards light half a wave-length more than its neighbours, the spectra are *fourfold in brightness*. Now these also would image lines, though falsely. The application to transparent microscopic objects need not be pointed out.

Yet the more we understand the true relations of these spectra, and their optical effects, the truer will our interpretations become, within, at least, the limits of microscopic vision, and the more certainly shall we be directed to methods of manipulation which may truly interpret the phenomena. Taking merely the theory of the matter, let us consider the case of fig. 41 where only the lines A A and B B really exist, but C C are apparent by the illusory spectra of the narrow spaces between A B, A B. It is plain we have means, if our suspicion as to the existence of C C C is awakened, of clearing it up. For we can stop off not only the central pencil, but those inner spectra which give us the coarsest intervals A A A. This will bring into stronger relief the spectra representing the next widest spaces, B A, B A, and thus we may correct the former result. Also it is obvious that any skilful manipulator with a knowledge of physical optics, by stopping off central pencils, and, when necessary, inner spectra, might bring into stronger relief the much fainter spectra caused by fainter and finer striations, which were before "drowned," as it were, in the coarser phenomena. Mr. Stephenson proved this in the case of *P. angulatum*, bringing out minute patterns, when the central pencil was stopped off, which had never before been seen.

It is also evident why so much is learnt from various incidence of the light; but it will also appear that this should be studied more gradually than most mirror arrangements permit. As a rule, microscopists adjust for one obliquity, and make their observation; then try another. It would rather appear that continuous observation under a steadily increased obliquity must be necessary to good interpretation; and that even then a competent knowledge of the physical phenomena of optical gratings is necessary, as well as a careful collation and comparison of the appearances with those presented under similar treatment by coarser objects, of which true dioptric images can be obtained. But even then it will be only a matter of interpretation more or less correct. All we know of *A. pellucida* is, that there are striæ, or ridges, or something occurring at intervals of so many to the inch. It is obvious they cannot be mere lines, as they appear to us; but as any "form" must involve another set of lines of at least double the minuteness, and probably far more, what is there can never be known, except from analogy and comparison with larger diatoms. As a rule, we must get lines only in minute structures, and as a rule, that appearance is certainly false. Nevertheless, the variations in distance between the spectra under gradually increased obliquity, and their consequent image-results, appears the most likely general method of ascertaining the true *proportions* of distances between striæ not all equidistant, while the successive stopping out of the inmost and brightest spectra appears the most promising general method of revealing those fainter spectra which may lie hidden behind, and which reveal some periodic variation in structure at the distances of the apparent lines.

**The Future of the Microscope.**—Amongst the reports on the South Kensington Loan Collection of Scientific Apparatus is one by Prof. Abbe on the "Optical Aids to Microscopy,"* the earlier part of which (pp. 383–91) is occupied with a general description of the stands, objectives, and other apparatus exhibited, with critical comments. The succeeding thirty pages are devoted to a consideration of "the facts which throw a light on the conditions of optical performance, and furnish hints in regard to further progress."†

The author commences with expressing the opinion that no *epoch-making* advance in the way of an extension of the domain of microscopical perception is now possible, although there is still great room for improvement in other, and in a relative sense minor, respects. The curve of progress, after having risen abruptly for several decades, appears to have a tendency towards an asymptote parallel to the base line.

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* Hoffmann, A. W., 'Bericht über die wissenschaftlichen Apparate auf der Londoner Internationalen Ausstellung im Jahre 1876.' 8vo, Braunschweig, 1878. Cf. pp. 383–420, Abbe, E., 'Die optischen Hülfsmittel der Mikroskopie.'

† It appeared to us, on a perusal of Professor Abbe's paper, that he had not given sufficient weight to the increase in aperture and resolving power obtained by the use of homogeneous immersion, but to our objections on that point he writes as follows:—"Your objection leaves out of sight the general point of view from which the question of further perfection of the Microscope is discussed here. When the article was written, the opinion was generally spread, still—even among microscopists—*that it was only a question of time that the Microscope should display the molecules themselves.* This opinion I had always in view during the whole discussion. Hence results the large standard applied by me in estimating and measuring progress. The increase of delineating power from 1·1 to 1·4 or 1·5 is an exceedingly *small* increase compared with the *supposed* increase from 1·1 to ∞. That half the wave-length in air 'is the approximate limit,' and that this will not be overcome in a 'considerable' extent is true, notwithstanding homogeneous immersion, having regard to the said standard of estimation. The *important* point is that the *wave-length* does constitute a limit; that the *value* of the wave-length may be reduced in some degree by media of higher refraction is the *subordinate* feature under the point of view of the paper."

A condensed and summarized statement is given of the theoretical principles on which the compound Microscope is based, including the author's now well-known views on the formation of the images of minute objects in microscopical vision, together with observations on the important function of aperture in the Microscope, and the increase of aperture obtained by immersion lenses as compared with dry.

The remainder of the paper is devoted to a consideration of the possible ways and means by which, in the future, new successes may be hoped for, "the most important practical advantage of a rational theory of the Microscope being that, destroying mere vague hopes, it enables a proper direction to be given to the aims of the inventor."

With regard to a still further extension of aperture beyond 1·5 (the refractive index of crown glass), the author suggests that it may be thought that in process of time transparent substances, available for the construction of objectives, will be discovered, whose refractive index will far exceed that of our existing kinds of glass, together with immersion fluids of similarly high refractive power, so as to give new scope to the immersion principle. What, however, he asks, will be gained by all this? We shall perhaps, with certain objects, such as diatoms, discover further indications of structure where we now see bare surfaces; in other objects, which now show only the typical striations, we shall see something more of the details of the actual structure by means of more strongly diffracted rays; but we should get on the whole little deeper insight into the real nature and composition of the minuter natural forms, even should the resolving power of the Microscope be increased to twice its present amount; for, whatever part of the structure cannot at present be correctly represented on account of its small size, will then also give an imperfect image, although presenting a somewhat higher degree of similarity than before. If, therefore, we are not to rest upon conjectures which surpass the horizon of our present knowledge (as, for instance, would be the expectation of the discovery of substances of considerably higher refractive power than has hitherto been found in any transparent substance), our progress in *this* direction in the future will be small, and the domain of microscopy will only be very slightly enlarged, the more so because every such advance, however great, will be but of limited utility to science, on account of very inconvenient conditions. For a given extension of the aperture can only render possible a correspondingly enhanced performance of the Microscope when the object is surrounded by a medium whose refractive index at least equals that aperture. If the Microscopes of the future should utilize the high refractive power of the diamond, all the objects would have to be imbedded in diamond, without any intervening substance. The result of this consideration is, therefore, that as long as aperture serves that specific function, which experiment and theory compel us to ascribe to it at present, there is a *limit* to the further improvement of the Microscope, which, according to the present condition of our knowledge, must be considered as insurmountable. The optics of the day have already so nearly approached this limit, that any very important improvement in the way of a further development is no longer to be anticipated. This limit to all optical observation, in the direction of minuteness, can be approximately defined by half the wave-length (in air); at least microscopical observation cannot be applied to objects which are smaller to a *considerable* extent than half the wave-lengths, although the latter can be somewhat exceeded with immersion lenses.

The measure of the details accessible to our vision is not an absolute one, but is related to the wave-length of the light by which in any particular case the image is formed. There is, therefore, a certain latitude which can be utilized to some extent in favour of optical perception. In observations with white light those rays predominate, in the formation of the image visible to our eye, which show the greatest intensity in the visible spectrum. The mean wave-length will therefore correspond with the bright green, and may be taken as $0 \cdot 55\ \mu$. Somewhat smaller wave-lengths, those of the blue rays, allow of effective observations with so-called monochromatic illumination, the advantages of which for the recognition of the finest details have long been known to the microscopist.

Still more favourable are the conditions of image-formation with photography, since in this case the wave-length of the violet rays, which are the active ones, is $0 \cdot 40\ \mu$ only. The performance of objectives under otherwise similar circumstances extends, therefore, perceptibly further with photography than with direct observation. Not only does the photograph show finer details at the limit of the resolving power than would be directly visible to the eye, but even when the object is not at the extreme limits of resolution, but the correctness of the image is yet more or less problematical, it gives a greater guarantee of the truth of the representation than does the ordinary image. Hence photo-micrography, in difficult examinations, has a value not to be underrated.

A further step may be taken in this direction by utilizing rays which probably lie far beyond the limits of the visible spectrum in the ultra-violet. If these images are not directly visible, it is possible to imagine them made visible by means of fluorescent substances. But for this the optician must have materials for the construction of the objective which possess at least the transparency of quartz for the ultra-violet rays, without those properties which now preclude its application for such a purpose, and substances of similar transparency must also be found for imbedding the object and for the immersion fluid.

This consideration shows to what extent we must quit the sure ground of experience if from our present standpoint we reckon on a *fundamental* improvement of microscopy. The result of such attempts leaves no prospect in the main of the realization in the future of hopes and wishes which rest on the notion of an ever-extending and unlimited improvement in our optical instruments. Judging from what lies within the horizon of our present knowledge, a limit is put to the range of our eyes by the action of light itself, a limit which is not to be overstepped with the tools given us by our present knowledge of nature. "There remains, of course," says the author, "the consolation that there is much between heaven and earth that is not dreamt of in our philosophy. Perhaps in the future human genius may succeed in making forces and processes serviceable which may enable the boundaries to be overstepped which now seem impassable. Such is, indeed, my idea. I believe, however, that those instruments which may perhaps in the future more effectively aid our senses in the investigation of the ultimate elements of the material world than the Microscope of the present, will have little else than the name in common with it."

There is, therefore, but small scope left for the advance of optical art, in regard to the most important point in the efficiency of the Microscope—aperture—the possible direction of which has been indicated in the foregoing observations. The further perfecting of the instrument must chiefly relate to the two other factors of its optical performance, viz. the magnifying power and the dioptrical exactitude with which the image is formed. In these is to be found the most important task left for the optician in reference to the Microscope.

With regard to the first—the amplification of the image—the author proceeds to explain in outline the point since dealt with more in detail in his papers on the relation of aperture to power,* and the uselessness of a magnifying power that is out of proportion to the aperture—increased size without visible detail, so that we have "mere emptiness." There is room for improvement of the eye-piece in reference to many points—the size of the field, the uniformity of the magnifying power, &c.; but they are points of subordinate importance, because they do not touch the performance of the Microscope in its most essential respects. The practical optician has, it appears, adopted this view. At least the fruitless efforts to increase the actual capacity of the Microscope by special eye-pieces have ceased.

It is an essentially different matter with the remaining factor. The conditions on which depend the more or less perfect union of the rays in an optical system are so manifold and so complex, and the ways and means of satisfying certain requirements are so numerous that a wide field will remain open to optical science for all time. The imperfection of the optical image at the focal point springs from two causes very similar in their effects. The one arises from the residual spherical and chromatic aberration which even the best devised combinations of refracting media still leave; the other lies in the want of homogeneity, precise form, and exact centering of the lenses which even the most perfect art can never wholly remove. The result is that every objective unites the cones of rays proceeding from the points of the object, not in mathematically exact image points, but in light surfaces of greater or less extent—circles of dissipation—and thereby limits the distinct representation when the details are of a certain minuteness.

Of course every part of the optical system, the objective as well as the eye-piece, contributes to this imperfection of the image. In its practical importance, however, the part played by each of the elements of the compound Microscope is extraordinarily different. If we disregard the faults of the image towards the margin of the field, and consider only the maximum sharpness of the image in the region of the axis, the eye-piece is, as a matter of fact, quite without influence. In the simplest eye-pieces with unachromatic lenses, their action in the centre of the field is practically free from error, when we estimate the conditions under which they act. It is undoubtedly accurate, as is often urged, that the eye-piece, even in the axis, exercises *an* influence on the spherical and chromatic aberration of the pencils, but at the same time as accurate as it is to say that the sun rises earlier for a tall man than it does for a short one.

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* See this Journal, ii. (1882) pp. 300 and 460, and iii. (1883) p. 790.

For the proper performance of the Microscope, those faults in the image are alone important which originate in the action of the *objective*, and are only enlarged in the objective-image by the eye-piece. From whatever cause these may spring, whether from external imperfection of the lenses, or from aberrations, their common influence consists in their imposing a certain limit to the useful magnifying power in the case of every objective. The more perfectly an objective of given focal length acts in both respects, the higher the magnifying power it admits of by means of tube and eye-piece; the more imperfect the union of the rays, the lower the magnifying power at which the dispersion circles from each point of the image destroy its sharpness and clearness. Moreover it is entirely unimportant in itself by what means a given magnifying power is to be produced, whether by longer tube and weaker eye-piece, or by shorter tube and stronger eye-piece; the amount of the *united* magnifying power is alone to be considered, and must be compared to the magnifying power which the objective, used as a magnifying glass, would give by itself. The ratio in which tube and eye-piece may increase the available magnifying power over that of the objective alone, without deterioration of the image, forms the exact standard of the perfection of an objective. On the one hand, this points out the reason why the attainment of a higher magnifying power always necessitates objectives of shorter focal length. This would not be the case if the objective could be arranged so as to unite the rays perfectly, for nothing would then hinder the production of any desired amplification of the image, by means of tube-length and eye-piece, however great the focal length of the objective might be. On the other hand, it is shown that every advance in perfecting the objective, with regard to its dioptrical functions, must enable amplifications, hitherto attained with sufficient clearness by lenses of short focal length only, to be equally well attained by lower power objectives.

A comparison of the Microscope of the present day with those which twenty, thirty, and forty years ago gave the best performance, shows the steady progress which optics have made in this respect. Without doubt it is of the greatest interest to examine what prospects there are for the further perfecting of optical instruments in this direction. If the opinion previously expressed on the importance of aperture and on the extreme limit of microscopical perception is right, no improvement of the objectives in their dioptrical action can substantially enhance the performance of the Microscope in the whole; for, with the present constitution of the objective, magnifying powers are attainable with which the smallest detail that can be represented is distinctly visible; *the progress will merely consist in obtaining in equal perfection the same amplifications that we now have at command by means of relatively lower power objectives.* But even this would be a matter of great practical importance if we should succeed in materially surpassing the present performance, so that, for instance, the strongest magnifying power, for which we now use lenses of 1 mm. and less focal length, would be at least as perfectly obtained with objectives of from 3 to 4 mm. Not only would the great difficulties be removed, which are now attendant upon work with high magnifying powers, in consequence of their too short working distance, but it would be no less an advantage that every objective would offer a greater latitude for useful magnifying power. Even with regard to purely optical perfection, the production of higher magnifying powers by stronger eye-pieces, instead of stronger objectives, would be a decided gain, by lessening certain faults in the image which impair its clearness outside the axis. The aberrations outside the axis (erroneously attributed to the convexity of the field) which in objectives of large aperture are always but very imperfectly corrected, vary for the most part with the *square* of the distance from the axis, for which reason their obnoxious influence will, with the employment of stronger eye-pieces, diminish more quickly than the magnifying power increases. Possible apprehensions of other drawbacks which might attend the use of stronger eye-pieces are groundless, for, if it should become necessary, combinations of lenses could be constructed, by which any high magnifying power that may be desired could be as conveniently obtained as with the present eye-pieces.

In judging of the ways and means which are open, according to this view, for the perfecting of the Microscope, we must consider the various sources of error which spring from its deficiencies.—At the present day an extraordinary perfection is attainable in the technical accomplishment of objectives. With technical aptitude and a rational method of work we can correctly produce given curves, even in very small lenses, up to a few thousandths of the radius. The irregular deviations of the surface from a strictly spherical form, however, can be restricted, when necessary, in their absolute quantity to small fractions of the wave-lengths and the centering of the separate surfaces can be exactly executed with exceedingly small deviations. With the exception, perhaps, of the strongest objectives, which, in consequence of their very small dimensions, allow of only uncertain means of measuring and proving, we can see the unavoidable errors diminishing almost to the vanishing point. The actual imperfections which are seen in the dioptrical working of the Microscope of the present time must chiefly be referred, therefore, to the imperfect correction of the aberrations.

The study of the conditions which must be fulfilled for the perfect correction of the chromatic and spherical aberrations in an objective shows two drawbacks not to be overcome by the practical optics of the day.

One arises from the unequal course of the dispersion in crown-glass and flint-glass, in consequence of which it is impossible with the present kinds of glass, to unite perfectly all the coloured rays in the image. In the best combinations of lenses which can be made, there is always therefore a considerable secondary chromatic aberration in the image which impairs its clearness.

The second still greater hindrance is the inequality of the spherical aberration of an objective for light of different colours, and the impossibility of compensating this inequality with our present resources. It is not difficult even with a large aperture (using light of one particular degree of refrangibility) to remove perfectly, practically speaking, the spherical aberration, at least in the axis, so that the objective, with monochromatic light of this fixed colour, will give an almost perfect union of the rays; the system is however under-corrected for the less refrangible rays, and over-corrected for the stronger. The larger the aperture of an objective, the greater of course will be the residual aberration which originates in this difference of the spherical correction for the various colours. Their effect appears in the form of a characteristic diversity which the chromatic correction of the objective shows for the different zones of the free aperture, an objective which possesses the most perfect possible chromatic correction for the central rays, and gives the most favourable images with direct illumination, being more or less strongly over-corrected chromatically for the peripheral rays, and with oblique illumination shows the outline of the object with distinct chromatic fringes, and conversely. In objectives of moderate aperture, perhaps up to 40° or 50°, we may restrict the detrimental effect of this chromatic difference of the spherical aberration, by dividing the refractions over a greater number of separate lenses than would be otherwise required by the aperture. English and American opticians have in this way constructed weak objectives of from 30 to 20 mm. focal length, which give a more perfect union of the rays than the corresponding more simply constructed lenses in use on the Continent, and which allow of a much higher magnifying power by means of draw-tube and eye-piece. The above-mentioned class of aberrations offer, however, an insurmountable difficulty in the case of the large apertures of dry and immersion objectives. The impossibility of removing them entirely with the present resources must be unquestionably considered the greatest difficulty which has hitherto hindered a more perfect action of the objective, with regard to its dioptrical working.

It is not difficult to define the cause from which this defect springs. The impossibility of removing the chromatic difference of spherical aberration, originates in the fact that with the existing kinds of glass (crown-glass and flint-glass), the dispersion increases with the mean refractive index in such a manner that greater dispersion always accompanies the higher index (with very slight deviations) and conversely. The aberrations could be compensated for, or at least nearly so, if there were materials applicable to optical purposes, by which a relatively smaller refractive index could be united with higher dispersive power, or a higher refractive index with a relatively lower dispersive power. It would then be possible by proper combination of such materials with the usual crown and flint glass, to partly remove the chromatic and spherical aberrations, independently of each other, and thus fulfil the essential conditions on which the removal of the chromatic difference depends.

As the defects of the present objectives, in regard to the chromatic as well as the spherical aberration, originate in the optical properties of the substances on which the optical art of the day is based, the further perfecting of the Microscope in its dioptrical working, is therefore chiefly dependent on the progress of the art of glass-making, and will in particular require, *that new kinds of glass should be produced, which admit of a better correction of the so-called secondary spectrum and which show a different relation of the refractive to the dispersive power than at present has been obtained.*

The hope that such claims can be satisfied, in the more or less distant future, and the way opened for a substantial perfecting of the Microscope, as well as of the other optical instruments, rests on thoroughly established facts. The mode in which, in the kinds of glass now used, the indications of refraction and of chromatic dispersion appear, need not be considered as a natural necessity. For a sufficient number of different transparent substances may be chosen from amongst natural minerals and out of the many artificially formed chemical compounds, which offer essentially different properties as regards their refraction and chromatic dispersion, only that in other respects they are not adapted for optical use. Experiments for the manufacture of glass with less secondary dispersion, which were undertaken several years ago in England, with the co-operation of Prof. Stokes, although they were without practical result, gave noteworthy suggestions on the specific effect of certain bases and acids on the refractive properties. The uniformity which the present kinds of glass show in their optical properties, is to be attributed to the fact that the glass factories have hitherto used only a small number of materials, scarcely any other than aluminium and thallium, besides silica, alkali, lime, and lead, and we might reckon with some confidence on a greater variety of production, if only the glass manufacturers, led by methodical study of the optical properties of various chemical elements in their combinations, would leave that very limited field.

Unfortunately there seems little hope under present circumstances of any important advance in this direction in the immediate future. The present prospect, on the contrary, indicates a state of affairs which endangers many scientific interests. The manufacture of optical glass has been for a long time not far removed from a kind of monopoly; at least the art is in the hands of so few, that competition is out of the question. Since Daguet's glass-works were closed, there are now only two such institutions, which supply the general demand, while the third, founded by Utzschneider and Fraunhofer—the only one in Germany—has remained exclusively in the service of one optical workshop. It must, it is true, be admitted that this art has made very important progress in many respects during the last thirty years. Not only are the present kinds of crown and flint glass produced in formerly unattained perfection, as regards purity, homogeneity, and freedom from colour, but the whole series of optical glass has been widely extended in one direction by the manufacture of flint glass which considerably surpasses the previous kinds in high refractive power and dispersion. This progress, however, is all in the direction of inherited tradition. The art of glass-making has not apparently started on a fresh path, to enrich practical optics with new materials, and from the lack of earnest competition, the business interests of the proprietors of this manufacture do not offer any special incentive to the pursuit of ends which do not promise them assured advantages. Further, let us reflect how dangerous it is, that a branch of industry so important and so indispensable to many sciences should be in the hands of the few, so to speak, for under these circumstances unfortunate coincidences might threaten its continuance, and occasion a serious calamity. It is therefore a vital question for optical and other sciences interested therein, that in the future more forces should be gathered into the field, and that a keener competition should call forth stronger incentives to progress.

We can scarcely suppose that private initiative will suffice to supply this need without a strong external impulse. Undertakings of this kind are attended with so much difficulty and necessitate so large an outlay for results, which even under favourable circumstances, are so remote, that they can have little attraction even for enterprising people. A great rise in the industry in question can scarcely be expected unless funds are freely granted for its furtherance by Corporations or the State. The field is open here for learned societies which are in a position to offer material help towards the needs of science, to perform a most beneficial and worthy task. For great and various interests are dependent on the increasing efficaciousness and progress of the glass-manufacture. It is not, by any means, the Microscope alone which is here considered, but all arts and sciences dependent on the use of optical resources.

A retrospect of the last portion of this discussion on the ways and means of perfecting the Microscope in the future, shows a more favourable prospect than the earlier considerations. As regards that part of the performance of the Microscope which touches the dioptrical functions of the objectives, an increasing improvement of the instrument in important points may be expected in the future. The difficulties which at present oppose further progress in this respect, and will perhaps long continue to do so, need not in any way be considered as insurmountable. This is the proper field in which optical art may hope to attain further results. The question of the best adapted and most advantageous means of solving the difficulty under consideration is certainly not exhausted either as regards theoretical optics, or those practical arts which co-operate in the work of opticians. Theory may, in time, by a deeper insight into optical problems, point out new methods of removing, more effectually than at present, the chromatic dispersion and spherical aberration in objectives; practical optics may, by the perfecting and refining of the method of work, render possible a still greater exactness of the mathematical forms which theory seeks to realise, and the art of glass-making may in the future produce new materials instead of those now used, which, in their optical properties, may offer more favourable conditions for the construction of perfect objectives than our present crown and flint-glass. Doubtless united efforts in this direction will result in a continual progress towards perfection of construction, which will bring great benefits to the scientific application of the Microscope, if even it does not increase the absolute capacity of performance of the instrument.

In this direction lie the ends attainable. Efforts grounded on a fundamentally different aspect of the question will be thwarted in the future, as in the past, by the barriers which nature opposes to human illusions.

**Webb's 'Optics without Mathematics.'**[*]—The author of this work makes the astonishing statement that "the magnifying power of the Microscope is more frequently given in superficial measure!" though he considers that "it is better for our purpose to reckon it in the linear form."

BENECKE, B.—Die Anwendung der Photographie zur Abbildung mikroskopischer Objecte. (The use of photography for representing microscopic objects.)
[Summary of recent papers on the subject by T. C. White, W. H. Walmsley, G. J. Johnson, R. Hitchcock, C. Kiär, &c.]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 109-13.

BOTTERILL, C.—Protoplasm. (Presidential Address to the Liverpool Microscopical Society.)
*Micr. News*, IV. (1884) pp. 57-68.

BRADBURY, W.—The Achromatic Object-glass, XXX.
*Engl. Mech.*, XXXVIII. (1884) pp. 485-7.
" " " " XXXI. Littrow's Formulæ.
*Engl. Mech.*, XXXIX. (1884) pp. 6-7.

"Brass and Glass," A night with.
[Report of Meeting of Western Microscopical Club.]
*Engl. Mech.*, XXXVIII. (1884) pp. 513-4.

BULLOCH, W. H.—The Congress Nose-piece.
[Reply to A. McCalla *infra*, agreeing that he suggested the idea, "but it is one thing to suggest an idea and another to put it into practical shape."]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 58-9.

C., J. D.—New Eye-piece Micrometer. [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 52.

D., E. T.—Graphic Microscopy.
II. Eyes of *Epeira conica.*
III. Palate of Limpet.
*Sci.-Gossip*, 1884, pp. 25-6 (1 pl.); pp. 49-50 (1 pl.).

Dallinger's (Rev. W. H.) Nomination to the Chair of the Society.
*Journ. of Science*, VI. (1884) p. 118.

DIPPEL, L.—Mikrographische Mittheilungen. (Microscopical Notes.)
[(1) The formula for *a* on p. 312 of his 'Handbook of General Microscopy.' (2) Remarks on some test-objects of the genus *Grammatophora.* (3) Correction-adjustment with homogeneous immersion objectives.] [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 23-33 (1 fig.).

Edison Electric Lamp, Homologous sections and molecules.
*Micr. Bull.*, I. (1884) p. 14.

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[*] See Bibliography, *infra*, p. 303.

**Engelmann**, T. W.—Das Mikrospectral-photometer, ein Apparat zur quantitativen Mikrospectralanalyse. (The microspectral photometer, an apparatus for quantitative microspectral analysis.) [*Post.*] *Bot. Ztg.*, XLII. (1884) pp. 81–8.

**Fawcett**, J. E.—Photomicrography.
[An ordinary camera can be used.] *Micr. News*, IV. (1884) pp. 52–3.

**Feussner**, K.—Ueber die Prismen zur Polarisation des Lichtes. (On prisms for the polarization of light.) [*Post.*]
*Zeitschr. f. Instrumentenk.*, IV. (1884) pp. 41–50 (8 figs).
*Nature*, XXIX. (1884) pp. 514–7 (8 figs.).

**Flesch**, M.—Ueber einen heizbaren, zu schnellem Wechsel der Temperatur geeigneten Objecttisch. (On a hot stage for a rapid change of temperature.) [*Post.*] *Zeitsch. f. Wiss. Mikr.*, I. (1884) pp. 33–8 (1 fig.).

**Francotte**, P.—Description d'une Chambre-claire. (Description of a camera lucida.) [*Post.*]
*Bull. Soc. Belg. Micr.*, X. (1884) pp. 77–9.

Gauss on the Object-glass. See Mellor, T. K.

**Giltay**, E.—Theorie der Wirkung und des Gebrauches der Camera Lucida. (Theory of the action and use of the camera lucida.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.* (1884) pp. 1–23 (10 figs.).

**Grunow**, J.—The Abbe Illuminator.
[Instructions for using this illuminator as constructed by him.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 22–3.

**Herrick**, S. B.—The Wonders of Plant Life under the Microscope. 248 pp. and 85 figs. 16mo, New York, 1883.

**Hitchcock**, R.—The Standard Micrometer of the American Society of Microscopists. [Cf. *supra*, p. 287.] *Amer. Mon. Micr. Journ.*, V. (1884) pp. 34–5.
" " "Our Advertisers."
[Brief notices of various American opticians.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 56–7.
" " Giant Electric Microscope.
[Notes as to the absence of novelty and the unsteadiness of the light.]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 57.

**Hurd** (F.) Portable Microscope.
[Statement only of "a design which he believes will prove satisfactory," packing 5 × 2¼ × 1¾ in.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 37–8.

Journal of the Royal Microscopical Society, Vol. III.
[Review.] *Journ. of Science*, VI. (1884) pp. 106–7.

**Julien**, A.—Immersion Apparatus.
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
*Amer. Nat.*, XVIII. (1884) p. 224.

**Karop**, G. C.—Table for Microscopical Purposes.
[Soft white wood, 2 ft. 9 in. long, 1 ft. 6 in. wide, and 2 ft. 3 in. high. No cross-bar to the legs in front. Top 1 in. thick, "so that at any time it may be planed afresh if discoloured or eroded by acids." On each side in front is a sliding board to serve as an arm-rest, 6 in. wide and 15 in. apart. A piece of plate glass 7 in. × 6 in. let in the top over a piece of white paper or card. Half the glass blackened behind, and on the card opposite the other half is marked a 3 × 1 space, with centering lines, microscopical measurements, magnifying powers, &c.]
*Journ. Quek. Micr. Club*, I. (1884) pp. 312–3 (1 fig.).

**Kitton**, F.—Drawing with the Microscope.
[Objects to E. Holmes' suggestion of placing the slide cover downwards (*ante*, p. 146) that "the upper and under surfaces of an object are not as a rule alike; a further objection is that all powers exceeding 4/10 could not work through an ordinary slide." Gives the Wollaston camera the preference over all others tried.]
*Sci.-Gossip*, 1884, pp. 41.

**Knauer**, F.—Das Mikroskop und seine Anwendung. (The Microscope and its use. *Naturhistoriker*, V. (1883) pp. 525–7 (*concl.*).

**Mainland.**—Substitute for a Revolving Table.
[Highly lacquered Japanese tray, 20 in. × 12 in.]
*Journ. Quek. Micr. Club*, I. (1884) p. 323.

**Matthews, J.**—Revolving Table.
[*Ante*, p. 147.] *Journ. Quek. Micr. Club*, I. (1884) p. 319.

**McCalla, A.**—The "Congress" Nose-piece.
[Claims to be the original inventor and not W. H. Bulloch.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 38 9.

" " "Give credit to whom credit is due." [Same subject.]
*The Microscope*, IV. (1884) pp. 30–3.

**Mellor, T. K.**— Gauss on the Object-glass.
*Engl. Mech.*, XXXIX. (1884) pp. 56–7.

**Michael, A. D.**—Polarization of light by a concave mirror of opal glass, or a piece of white china. *Journ. Quek. Micr. Club*, I. (1884) pp. 323–4.

"Microscopists" and the position of the Microscope.
["The statement is often made that the Microscope owes its present approximation to perfection, and microscopical methods their extensive development, to "microscopists," that term being applied to those who consider the Microscope as an end, not a means, and whose whole use of the instrument is confined to the resolution of test-objects and the study of the marking of diatoms. Nothing is more erroneous. The Microscope is far more in debt to the biologist who uses it as a means to solve some problem. To him we owe all our methods for staining, all our facilities for section-cutting, and every discovery in the use of microchemical reagents."]
*Science Record*, II. (1884) p. 87.

"Monachus."—Microscopic Test-Objects.
[Reply to L. Wright and E. M. Nelson, *infra*.]
*Engl. Mech.*, XXXVIII. (1884) pp. 517 and 560.

**Moore, A. Y.**—Slide of *Amphipleura pellucida* mounted in a medium of refractive index 2·3. [*Infra*, p. 319.] *Amer. Mon. Micr. Journ.*, V. (1884) p. 37.

" " The Parabola as an Illuminator for Homogeneous-immersion Objectives. [*Post.*] *The Microscope*, IV. (1884) pp. 27–30 (1 fig.).

**Nelson, E. M.**—Microscopic Test-Objects.
[Reply to (1) "Monachus," *ante*, p. 141—*supra*, p. 288; (2) T. T., *ante*, p. 148; and (3) L. Wright *infra*.]
*Engl. Mech.*, XXXVIII. (1884) pp. 516–7 (4 figs.).

" " Möller's Probe-Platte.
[Remarks on plates mounted in phosphorus, monobromide, balsam, and dry.]
*Engl. Mech.*, XXXVIII. (1884) p. 540.

" " Microscopic Test-Objects.
[Further in reply to "Monachus."]
*Engl. Mech.*, XXXVIII. (1884) p. 560 (4 figs.).

" " On the Selection and Use of Microscopical Apparatus.
[*Résumé* of "demonstration" at the Quekett Microscopical Club.]
*Engl. Mech.*, XXXIX. (1884) p. 48.

**Ollard, J. A.**—Simple form of Revolving Table made out of two mincing boards.
[Exhibition only.]
*Journ. Quek. Micr. Club*, I. (1884) p. 323.

**Pelletan, J.**—Le Microscope "Continental."
[Warning against imitations !] *Journ. de Micr] *Journ. de Microgr.*, VIII. (1884) p. 121.

**Pendlebury, C.**—Lenses and Systems of Lenses, treated after the manner of Gauss. 95 pp. and 24 figs. 8vo, Cambridge, 1884.

**Penny, W. G.**—Theory of the Eye-piece. IV. Distortion of Curvature.
*Engl. Mech.*, XXXVIII. (1884) p. 497 (1 fig.).

" " " " V. Summary of Formulæ—On Further Approximations for the Distortion, and General Remarks—Proposed Eye-piece.
["The first lens plano-concave, the second plano-convex, with focal length *numerically* equal to that of the first, and placed at a distance from it equal to twice the focal length of the eye-lens, the curved side of each of

them being turned towards the eye." Proposed to be called "an undistorted eye-piece, not because the distortion is absolutely 0, but because it would seem to be much smaller than that of those in use."
*Engl. Mech.*, XXXVIII. (1884) p. 541.

Physicians, Microscopes for.
[Recommendation of Beck's 'Economic.']
*Cinc. Med. News*, XVI. (1883) pp. 833–4.

"Prismatique."—Object-glass working, XI.
*Engl. Mech.*, XXXIX. (1884) p. 24.

Prize, Questions for Examination in Competition for Bulloch and Grunow's.
4to, 1 p. (11th February, 1884).
[Seventeen questions on optics, lenses, objectives, camera lucida, magnifying powers, diffraction, and mounting. Open to any student in the senior class for five years of the Chicago Medical College.]

Queen's (J. W. & Co.) New Spot-lens Mounting. [*Post.*]
*Micr. Bull.*, I. (1884) p. 11 (3 figs.).

Rogers, W. A.—Corrections to paper on the "Conditions of success in the construction and the comparison of standards of length."
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting (1883) pp. 240–1.

Rohrbach, C.—A new fluid of great specific gravity, of large index of refraction, and of great dispersion.
[100 parts of iodide of barium are mixed with 130 parts of scarlet biniodide of mercury. About 200 cc. of distilled water are added to the powders, and they are then stirred up with a glass rod while heated in a test-tube plunged into an oil bath previously warmed to 150° or 200° C. A fluid double iodide of mercury and barium is formed, which is then poured into a shallow porcelain dish and evaporated down until it acquires a density so great that a crystal of epidote no longer sinks in it. When cold even topaz will float in it. It is then filtered through glass-wool. The fluid so prepared has a density of 3·575–3·588, boils at about 145°, and is of a yellow colour. Its refractive index is 1·7755 for the C line, and 1·8265 for the E line of the spectrum. For the two D lines of sodium the refractive indices are 1·7931 and 1·7933 respectively. So great is the dispersion that, using a single hollow prism with a refracting power of 60°, the dispersion between the two D lines is almost exactly 2′ of angle.]
*Amer. Journ. Sci.*, XXVI. (1883) p. 406.
from *Ann. Physik u. Chem.*, No. 9, pp. 169–74.

Skip, A.—Address to the Lehigh Valley Microscopical Society.
(On the value of the Microscope.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 39–40.

Slack, H. J.—Pleasant Hours with the Microscope.
[Horizontal position of Microscope. *Post.*]
*Knowledge*, V., (1884) pp. 109–10.

Stodder, C., Death of. *Micr. Bull.*, I. (1884) p. 9.
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 55–6.

Stokes, A. W.—Simple apparatus for aërating living fish whilst under microscopical observation. [*Supra*, p. 286.]
*Journ. Quek. Micr. Club*, I. (1884) pp. 322–3 (2 figs.).

Stowell, C. H.—Gleanings from the Journ. R.M.S. for December.
[Claims for Mr. E. H. Griffith the invention of a Revolver Microscope similar to Mirand's, III. (1883) p. 897, and of a nose-piece adapter similar to Matthews's, ibid., p. 903.]
*The Microscope*, IV. (1884) pp. 35–7.

Stowell, C. H. and L. R.—Proceedings of the American Society.
[Urging earlier publication.]
*The Microscope*, IV. (1884) p. 39.

Washington Microscopical Society, formation of.
*Amer. Mon. Micr. Journ.*, V. (1884) p. 58.

Wassell, H. A.—Plate Glass for Optical work.
*Engl. Mech.*, XXXIX. (1884) p. 57.

Webb, T. W.—Optics without Mathematics. 8vo, London, n.d., 124 pp. and 58 figs. [Microscope, pp. 61–6, 107–8. *Supra*, p. 300.]

WICKSTEED, R. J.—The Microscope; its history, construction, utility and improvement.
[Title only of communication to the Ottawa Microscopical Society.]
*Science*, III. (1884) p. v.

WRIGHT, L.—Microscopic Test-Objects—Aperture and Resolution.
[Criticism of "Monachus" and E. M. Nelson.]
*Engl. Mech.*, XXXVIII. (1884) pp. 470–1 (2 figs.).

" " Microscopic Tests.
[Reply to "Monachus" and E. M. Nelson.]
*Engl. Mech.*, XXXIX. (1884) p. 34.

Zentmayer's Nose-piece. [*Supra*, p. 285.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 42–3 (1 fig.).

### β. Collecting, Mounting and Examining Objects, &c.

**Preparing and Mounting Sections of Teeth and Bone.***—J. E. Ady explains as follows what he terms the "laccic" method of occlusion.

1st. Saw a piece off the tooth or bone, rub it flat on an engineer's file, polish the flat surface on a fine hone, Water-of-Ayr stone being preferable.

2nd. Fasten the section on to a piece of plate-glass, 1 in. square, with a cement made by melting six parts of "button" lac with one part Venice turpentine.

3rd. File the section down moderately thin, and then reduce further on the Water-of-Ayr stone, examining from time to time with the Microscope.

4th. Soak the section off with strong methylated spirit, wash thoroughly in clean spirit, and dry between tissue paper.

5th. Make a thin solution of white shellac in methylated spirit, filter, and keep in a stoppered bottle.

The section is to be dipped in this solution, drained, and laid on a cold plate under a bell-glass. In about half an hour it will be dry.

6th. Mount in cold balsam and benzol in preference, in order to avoid heating the section, as that would give it a tendency to curl; but as the melting point of the shellac is higher than that of the balsam, the latter may be used if thought desirable, as it may even be caused to boil without affecting the shellac.

**Expanding the Blow-fly's Tongue.**†—C. M. Vorce writes:—

If the head of a living fly be cut off, the tongue will usually retract; pressure on the head will expand the tongue, but unless it be secured by some means before the pressure on the head is released, it is apt to wholly or partly retract again. If only the tip is wanted, it is easily secured by placing the severed head on a clean slip and pressing it with a needle till the tongue is fully expanded, when a drop of turpentine is applied, a cover laid on the tongue, and a clip applied before the pressure is removed from the tongue. To secure the whole tongue, split one end of a small stick for an inch or so, and holding the split open by a knife-blade, place the severed head in the cleft with the top downward, and, withdrawing the knife-blade, allow the stick to close upon the head, when it will fully distend the tongue. Now dip the head and tongue in turpentine and leave it immersed for a few days, when it will be found well cleaned, still perfectly distended, and can be released from the stick or cut from the head without danger of its collapsing. Mounted in a cell in balsam, it is a truly beautiful object.

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* Journ. Quek. Micr. Club, i. (1884) p. 332.

† Amer. Mon. Micr. Journ., v. (1884) p. 12.

**Perchloride of Iron as a reagent for Preserving Delicate Marine Animals.**—We have already referred (vol. iii. (1883) p. 729) to Dr. H. Fol's objection that the reagents in common use for instantaneous killing, such as picro-sulphuric acid, osmic acid alone or in combination with chromic and acetic acid, and corrosive sublimate, fail to give successful preparations, and noted his success with perchloride of iron. He now adds some further remarks on the subject.*

An alcoholic solution diluted to about 2 per cent. will answer ordinary purposes, but a stronger solution should be used in case it is desired to kill a large number of animals in a large vessel. It will not do, however, to turn a saturated solution directly into sea water, as precipitates would be copiously formed which would utterly ruin the preparations. After the animals have sunk to the bottom of the vessel, most of the water may be turned off, and 70 per cent. alcohol added. In order to remove from the tissues the ferric salts adhering to them, it is necessary to replace this alcohol with alcohol containing a few drops of hydrochloric acid.

The "fixation" of the animals in an expanded life-like form is perfect, and the action of the dilute acid is of so short a duration that it causes no injury to the tissues. Not only infusoria and Rhizopods, but also large pelagic animals, such as Medusæ, Ctenophora, Salpæ, Heteropods, *Doliolum*, &c., may be thus killed and transferred to alcohol, with their form, histological structure, and cilia perfectly preserved. After complete removal of the yellowish colour due to the presence of ferric salts by washing in acidulated alcohol, the tissues of transparent animals remain almost free from cloudiness.

The best method of staining such objects is to add a few drops of gallic acid (1 per cent. solution) to the alcohol. After twenty-four hours the alcohol is turned off, and pure alcohol added. Thus treated, the protoplasm will take a light-brown colour, the nuclei a much deeper brown. Carmine stains too deeply and diffusely, and cannot be successfully removed.

**Action of Tannin on Infusoria.**†—H. Gilliatt, struck with the remarkable appearance shown in Mr. Waddington's illustrations (vol. iii. (1883) p. 185), made a number of experiments with glycerole of tannin, as described by him. On exposing *Paramecium aurelia* to the action of the tannin, he found the effect quite as startling as described; the animalcules, as the acid began to affect them, darted about with great rapidity, endeavouring to conceal themselves beneath any vegetable matter on the slip, their motions gradually growing slower; then they revolved slowly two or three times. A sudden contraction of the body followed, and in a few seconds the appearance shown in Mr. Waddington's illustrations.

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* Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 491–2. See Amer. Natural., xviii. (1884) pp. 218–9.

† Proc. Linn. Soc. N. S. Wales, viii. (1883) pp. 383–6.

The regularity of the fine transparent acicular fringe that now surrounded the animalcule, or whether it was completely thrown off, appeared to depend, as described by Mr. Waddington, on the strength of the solution. In those cases where the appendages were separated from the body, it was not unusual to find a few spiral shaped, although after careful comparison the majority were rod-like.

After examination of numerous specimens treated with the acid, it seemed difficult to reconcile cilia of such length—in some cases exceeding the width of the body—with the action apparent in the ciliary movements of the living animalcule. But while observing an example under oblique illumination, Mr. Gilliatt was struck with the appearance of fine lines across it, and was thus reminded of the rod-like bodies or trichocysts so fully developed beneath the cuticle of *P. aurelia*; and after referring to the views of W. S. Kent, Stein, Allman, and Ellis, on the effects produced "on the trichocysts by the use of acetic acid, or a small stalk of *Geranium zonale* (Horseshoe Geranium), he considers that it may be "fairly concluded that the effects observed by Mr. Waddington in his experiments must be attributed to the action of tannic acid on the trichocysts of *Paramecium aurelia*, and not, as he considers, to its action on the cilia."

Professor D. S. Kellicott [*] has also satisfied himself that the bodies are trichocysts. Glycerole of tannin acts even more energetically than acetic acid, and is, he considers, sure to become a valuable reagent in the study of infusoria. By applying in proper dilution, the infusorian is not at once killed, and the cilia may be seen yet in motion, with the trichocysts extending far beyond them.

Another writer [†] refers to "the hirsute covering of *Paramecium* and other infusoria shown when a solution of quinine is added to the water in which they live, although the cilia are quite invisible when the animals are swimming about. Quinine may prove to be a valuable reagent for killing the infusoria and rendering their cilia visible."

**Preparing Fresh-water Rhizopoda.**[‡]—In fixing the living animal, K. J. Taránek uses small (8–10 cm. long) pieces of soft red blotting-paper of triangular shape, and, in order to draw off the water under the cover-glass, lays a piece of this paper upon the slide in such wise that the point of it reaches the edge of the cover-glass, and comes in contact with the water beneath. The blotting-paper immediately causes a current, which, however, is very weak, as only the corner of the paper is active. If the current is strong, so that the animal begins to move with the water, the paper must be removed; but if the current is weak, which can be well regulated by the shape of the blotting-paper, the animal keeps its position unaltered; and as by the absorption of the water the cover-glass exercises greater pressure upon the slide, there is less danger of losing the animal from the field. Then add to the opposite edge of the cover-glass by means of a glass rod a drop of 1/2 per cent. osmic acid, which immediately penetrates to and kills the animal without altering its shape. In the same way are added to the preparation the different alcohols, 15, 45, 90, up to 100 per cent., whereby the animal obtains the required hardness. Then follows the staining with picro-carmine or methyl green (which have proved to be the best for Protozoa). In the same manner, after 5–7 minutes the stream of colour is replaced by weak alcohol (50–30 per cent.), when the whole preparation is complete.

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[*] Bull. Buffalo Nat. Field Club, i. (1883) p. 110.

[†] Engl. Mech., xxxviii. (1883).

[‡] Abh. math.-naturwiss. Cl. K. Böhm. Gesell. Wiss., xi. (1882) Art. No. 8, iv. and 56 pp. (5 pls.). See also *supra*, p. 247.

This method is very simple and very quick, the whole manipulation lasting 7–12 minutes, so that the preparation is finished in a quarter of an hour. Care must be taken to have the object always in sight, and not to keep up too strong a current.

The stained object can be well examined in the weak alcohol, and, if the blotting paper is removed, can be kept whole hours in it. The manipulation is well adapted for drawing with the camera; but to make a permanent preparation, it must be treated with a clearing fluid, glycerine, oil of cloves, &c., and finally with Canada balsam, which, dissolved in benzine, is quite thin and liquid. The application of the clearing fluids is the chief difficulty in the preparation, because the absolute alcohol flows through quicker than the liquids which follow, which gives rise to small air-bubbles between the two liquids. "It is, of course, obvious that the preparations often do not come up to the requirements of our day, especially as regards beauty. For, beside the objects prepared, there are a number of algæ, infusoria, mud, &c., in the preparations, by which they are made more or less dirty."

**Arranging Diatoms.***—E. H. Griffith thinks that those who wish to arrange diatoms will find the following of great assistance:—

With a pipette place the diatoms on a film of mica, as the mica is very thin, and when mounted can instantly be heated to an intense heat over an alcohol lamp. With a pair of scissors cut small strips from the best part of the diatom field of mica, moisten the mica on the other side and lay it on the prepared slide near the centre of the slip to be used, or if the diatoms are to be mounted on a cover-glass, place the strip near it, and with a pen make a delicate dot of ink on the under side of the slide to mark the place for placing the diatom. From the mica the diatoms can be very easily picked, while from the glass sometimes it is almost impossible to pick them. Several strips of mica may be placed side by side with different kinds of diatoms if desired.

Instead of putting the diatoms on a cover-glass and the cover-glass on a metal strip, in order that organic matter may be burned away over a spirit-lamp, put them with a pipette on the end of a thin strip of mica and then burn them, avoiding the great annoyance of having a cover-glass, diatoms and all, slide or fly off. The mica being thin and a poor conductor of heat, the end may be brought to a red heat almost instantly. Now place a glass slip on the turntable, and make a dot or a small circle in the centre as a guide for placing the diatoms. Turn the marked side down, and with gelatine or other material size the spot over the dot or circle; then with scissors cut from the film of mica a small piece from the best part of the diatom field, moisten the other side and lay it on the glass slide near the marked centre. A crescent-shaped piece may be cut, if desired, that may extend partially around the marked spot. The mica being thin, the focus of low powers need not be changed while transferring the diatoms from the mica to the slide, and one trial will demonstrate that it is much easier to pick from mica than from glass; also that there is less danger of having the mica fall from the slide while at work. Those who desire to make the arrangement on a cover-glass can do so by placing a cover over the marked centre, sizing it, and then transferring to the cover instead of to the slide.

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* The Microscope, iii. (1883) pp. 205–6.

**Mounting Diatoms in Series.***—P. Francotte uses Threlfall's method † for arranging diatoms in series. The solution of caoutchouc being poured upon the slide, the benzine evaporates, and the diatoms are arranged; it is then slightly heated, and the diatoms sink into the layer of caoutchouc, where they remain definitively fixed, and can be covered with a thin glass coated with balsam.

**Synoptical Preparation of Pulverulent Objects (Diatoms from Guano, Fossil Earths, &c.).** ‡—P. Barré describes as follows his process of making these preparations, which enable specimens of different pulverulent objects to be compared.

After covering one of the surfaces of a cover-glass with balsam in the manner described for arranging diatoms, § and heating it until the hardened balsam no longer contains any trace of chloroform, the cover-glass is placed in the instrument fig. 42, A. *a* is a plate of brass, ·75 mm. in thickness. *b* is a strip of steel, fixed at *e* to the plate *a*, and to which is riveted another brass plate *c*. To the latter are soldered nine copper tubes, made as thin as possible (1/5 or 1/6 mm.) These tubes pass through the plate *c*, and project about 1 mm. from its under surface. The tubes are of exactly the same length, so that the cover-glass, covered with hardened balsam, meets all the nine tubes at once.

The plate *a* has a rectangular aperture *d* (indicated by dotted lines), and exactly opposite to the orifices of the nine tubes in the plate *c*.

The cover-glass is placed between *a* and the tubes, the surface covered with balsam being *in contact with the nine tubes*.

This operation complete, a copper or steel wire, or even simply an ordinary pin, is introduced transversely between the lower surface of the cover-glass and the square opening (fig. 42, B). This causes the cover-glass to rest with equal pressure on all the nine tubes at once.

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* Bull. Soc. Belg. Micr., x. (1884) p. 65.

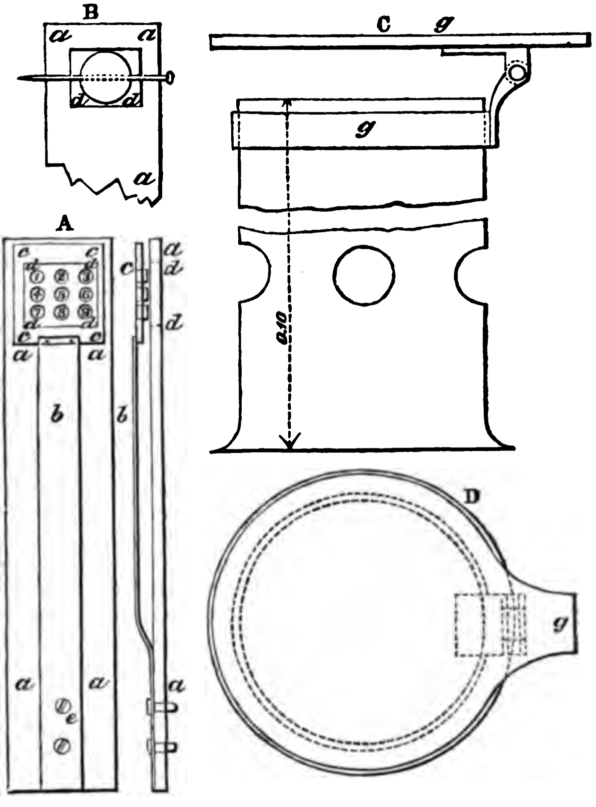
† See this Journal, iii. (1883) p. 600.

‡ Bull. Soc. Belg. Micr., x. (1883) pp.16-18 (1 pl.).

§ See this Journal, iii.(1883) p. 453 (1 pl.).

Thus prepared, the glass, fixed in the instrument, is exposed to the heat of a spirit-lamp. The balsam is again liquefied, the extremity of the tubes in contact with it become attached, and it is then allowed to cool.

FIG. 42.



The varieties of powder containing diatoms are then introduced into the tubes by means of a quill, and spread by a fine and very soft brush on the inner surface of each tube. The operation should be performed very carefully, so as not to allow particles of powder to fall into the adjoining tubes. The glass is again heated, and the diatoms adhere to the softened balsam in all the tubes at once—after which it is again allowed to cool. Then, by raising the spring *b*, the cover-glass is carefully loosened, and can then be detached with a slight pressure. The surface of the glass having the diatoms is then blown and brushed, and the preparation is completed by the process described for arranging diatoms.

The essential point of the operation is in sufficiently hardening the balsam on the cover-glass. The heating must be carried as far as is possible without altering the colour. To succeed, it is advisable to cover the spirit-lamp with a metal chimney to avoid the flickering of the flame. This chimney has a cap (*g*, fig. 42, C and D), movable vertically, so that it can be raised or lowered. It is also convenient to joint it in such a manner that the hot plate can be placed perpendicularly, if desired.

It is, of course, permissible to increase at pleasure the number of tubes. The author makes preparations containing sixteen and even twenty-five varieties of earths; and expects to greatly exceed this number. Indeed, the only limit is the size of the cover-glass.

**Logwood Staining.***—A. C. Cole says that "up to the present time, no stain has been found to equal logwood for certainty and permanency of results, and beauty of colour, which, besides being beautiful, is also not too tiring for the eye. We go further, and say that the more a histologist departs from a use of logwood and adopts other stains, the more unsatisfactory will be his total results. If ten men were each to make for himself a histological cabinet, the work of each being equal in other ways, the one who would produce the best cabinet would be found to have used logwood and picro-carminate of ammonia for the great majority of his slides, using other stains which have been found to suit special cases, such as aniline-blue-black for nerve-centres, methyl-aniline for amyloid or waxy degenerations in pathological histology in a few cases only. He would further have been found to have used benzole balsam as his mounting medium in the case of his logwood stains, and glycerine jelly for mounting his picro-carmine slides. Such a cabinet would last a thousand years, and be as perfect the last day as on the first. On the other hand, the worst cabinet, especially after, say about ten years, would be found to have been composed of a few logwood slides, mounted in dammar varnish, and the great majority stained with all sorts of aniline and other fancy dyes, and mounted in glycerine. The dammar preparations would be found to be little better than fine grey dust, and the fancy dyes to be conspicuous by their absence. So far as can be judged by our present data, a preparation stained with logwood and mounted in balsam is unchangeable; so is a preparation stained with picro-carminate of ammonia and mounted in good glycerine jelly.

With these preliminary remarks, we now proceed to give formulæ for those stains, and those only, which have been found really good in every way. As staining is yet in its infancy, we daily read of a fresh stain, and a new method of staining. We need scarcely draw the attention of our readers to the present mania for 'rushing into print,' and the numerous worthless, not to say senseless, communications to our various journals on the subject of dyes for histological work. We advise the histologist to ask himself this question:—Is it my object to make for myself a complete educative histological cabinet, or to investigate the subject of stains, and therefore to experiment with the various stains? The operator should settle this question once for all, and *before* he commences his work."

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* 'The Methods of Microscopical Research,' Part VII. (1884) p. xli.

**Staining with Hæmatoxylon.***—Dr. C. L. Mitchell describes a new and simple method of preparing a logwood staining fluid, by which a permanent, reliable, and satisfactory preparation can, he claims, be easily made, and which places within the reach of every microscopist, a staining fluid "stable in composition, comparatively easy of preparation, and unequalled in the delicacy and clearness of differentiation of its colouring."

In staining fluids prepared from extract of logwood, the partially oxydized tannin in the liquid gradually absorbs more oxygen from the air and changes to other complex organic compounds; the colouring matter is also affected by the decomposition, and gradually becomes converted into other substances, and the liquid finally becomes of a dirty muddy colour, and is half filled with a lumpy sediment. This change will be found to take place in all ordinary logwood staining fluids, whether prepared from the extract or from the drug itself, although from the nature of the case those made from the extract would be most quickly affected. The idea therefore occurred to the author, that if the tannin could be removed, and the lake of logwood isolated in a state of comparative purity, a staining fluid could be prepared which might possibly be both permanent and satisfactory, and the following formula is the result of his investigation:—

*Mitchell's Hematin Staining Fluid.*

| | | |
|---|---|---|
| ℞ | Finely ground logwood .. .. .. .. .. | ℥ ij. |
| | Sulph. alumin. and potash (potash alum) .. | ix. |
| | Glycerine .. .. .. .. .. .. .. .. | f. ℥ iv. |
| | Distilled water .. .. .. .. | a sufficient quantity. |

Moisten the ground logwood with sufficient cold water to slightly dampen it, place it in a funnel or percolator, packing it loosely and then percolate sufficient water through the drug until the liquid coming from the percolator is but slightly coloured. Allow the drug to drain thoroughly, and then remove it from the percolator and spread out on a paper or board to dry. Dissolve the alum in eight fluid ounces of water, moisten the dry drug with a sufficient quantity of the fluid and again pack in the percolator, this time rather tightly, and pour on the remainder of the alum solution. As soon as the liquid percolates through and commences to drop from the end of the percolator, close the aperture with a tightly fitting cork and allow the drug to macerate for forty-eight hours. Remove the cork at the expiration of that time, allow the liquid to drain off, and then pour sufficient water upon the drug to percolate through twelve fluid ounces altogether. Mix this with the glycerine, filter and place in a close-stopped bottle.

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* Proc. Acad. Nat. Sci. Philad., 1883, pp. 297-300.

In this process nearly all the tannin is removed by percolating the drug with cold water, a menstruum in which the colouring principle is not very soluble, and the subsequent maceration and percolation with the alum solution removes the logwood lake in a state of comparative purity. The glycerine is added simply for its preservative qualities, and this may still be increased by the addition of a few drachms of alcohol to the solution.

The hematin staining fluid thus prepared is a clear heavy fluid of a deep purplish red colour. It will keep its colour for a length of time and deposits no sediment. A sample exhibited by the author had been made for nearly a year, frequently exposed to a strong light and open to the air, but was unchanged. Permanent and beautiful in its colour, which is of a delicate violet hue, clear and sharp in its definition of the different tissues under examination, it will bear use with the very highest powers and it is hoped enables observers to distinguish minute differences of tissue which have hitherto escaped notice.

As to the method of using the fluid, it yields good results when used undiluted, as a quick stain; but the best results are obtained by placing the tissues in a weak solution (ten drops to two fluid drachms) with warm distilled water for about twelve hours. This produces results of surpassing delicacy and beauty.

**Dry Injection-masses** *—The variously coloured gelatine emulsions in common use as injections keep for only a short time, and have, therefore, to be prepared as occasion arises for their use. The dry emulsions recommended by Dr. H. Fol are very easily prepared and convenient in use. As they will keep for any length of time they can be prepared in quantities, and will thus be ready for use at any moment.

*Carmine Emulsion.*—One kilogramme gelatine (softer kind used in photography), soaked in water for a few hours until thoroughly softened; after turning off the water, heat the gelatine over a water bath until liquefied, and then add to it, little by little, one litre of a strong solution of carmine in ammonia. The mixture, stiffened by cooling, is cut up, and the pieces packed in a fine piece of netting. Vigorous pressure with the hand under water forces the emulsion through the net in the form of fine strings or vermicelli. These strings are placed in a sieve and washed until they are free from acid or excess of ammonia; then collected and re-dissolved by heating. The liquid is poured upon large sheets of parchment which have been saturated with paraffin, and these sheets are then hung up to dry in an airy place. The dried layers of the emulsion, which are easily separated from the parchment, may be cut into strips and placed where they are protected from dust and dampness.

The carmine solution used in this emulsion is prepared as follows:—A strong solution of ammonia is diluted with 3–4 volumes of water, and carmine added in excess. After filtering, the solution is mixed with the gelatine, and then enough acetic acid added to change the dark purple-red into blood-red. It is not necessary to completely neutralize the ammonia. The dry emulsion requires only to be placed in water for a few minutes and melted over the water-bath to be ready for use.

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* Zeitschr. f. Wiss. Zool., xxxviii. (1883) pp. 492–5. Cf. Amer. Natural., xviii. (1884) pp. 219–20.

*Blue Emulsion.*—A slightly modified form of Thiersch's formula:—
1. To 300 ccm. of melted gelatine add 120 ccm. of a cold saturated solution of green vitriol (ferro-sulphate).

2. To 600 ccm. of melted gelatine add first 240 ccm. of a saturated solution of oxalic acid, then 240 ccm. of a cold saturated solution of red prussiate of potash (potassic ferricyanide).

3. No. 1 poured slowly into No. 2 while stirring vigorously; the mixture heated for 15 minutes.

4. After cooling, the emulsion is pressed through netting, the vermicelli washed and spread on waxed paper for drying. In this case the vermicelli must be dried directly, as they do not melt well without the addition of oxalic acid.

The dry vermicelli are prepared for use by first soaking in cold water, and then heating with the addition of oxalic acid enough to reduce them to a liquid.

*Black Emulsion.*—1. Soak 500 g. gelatine in two litres of water in which 140 g. of common salt have previously been dissolved, and melt the mass on the water-bath.

2. Dissolve 300 g. nitrate of silver in one litre distilled water.

3. No. 2 poured very slowly into No. 1 while stirring. An extremely fine-grained emulsion may be obtained by using 3–4 times as much water in Nos. 1 and 2.

4. No. 3 pressed into vermicelli as above, and then mixed with No. 5. by clear daylight.

5. Mix 1½ litre cold-saturated potassic oxalate with 500 ccm. of a cold-saturated solution of ferro-sulphate.

6. No. 4 mixed with No. 5 gives a thoroughly black emulsion, which should be washed several hours, again melted, and finally poured in a thin layer on waxed paper.

A grey-black emulsion may be obtained by using 240 g. potassic bromide in the place of common salt in No. 1, the remaining operations being the same.

**Schering's Celloidin for Imbedding.***—Mr. G. C. Karop finds that a form of pyroxylin, known as Schering's patent celloidin, used by photographers for making a uniform quality of collodion, is an excellent material for imbedding. It is in the form of flat cakes of extremely tough, horny consistence, and "said to be non-explosive," burning like paper, and simply carbonizing if heated in a test-tube.

"A sufficient quantity is cut up and dissolved in equal parts of absolute alcohol and absolute methylated ether 0·717, until the solution is thin enough to pour. This takes some time, and the mixture should be well stirred daily, and kept in a warm room. The mass to be cut is hardened in any desired manner, and fastened by needles in the requisite position for cutting in a paper case the same size as the well of the microtome. The celloidin solution is poured in as free from bubbles as possible, and allowed to set slightly. The paper case and its contents is then placed in a quantity of methylated alcohol of 80°, not less, as otherwise the colloidin becomes tough, and not more, or it will dissolve it. It is left in this until of the proper consistence to cut, about as firm as boiled egg albumen. If possible, the sections should be cut under the surface of methylated spirit. Katsch's machine is made for, and is simply perfect for this purpose, but sections can be cut very well if the whole surface of the microtome in use is kept flooded with spirit. The sections can be stained by any of the ordinary fluids; the celloidin takes a slight stain, but as it is perfectly amorphous it does not in any way interfere, and can, of course, if the species of section admit it, be dissolved away by the mixture of ether and alcohol. On the whole, it seemed about the best thing for the purpose that he had met with, and members might judge of its fitness by the fact that it enabled one to cut sections of the whole eye, every structure remaining *in situ*, a feat he supposed impossible with any other material."

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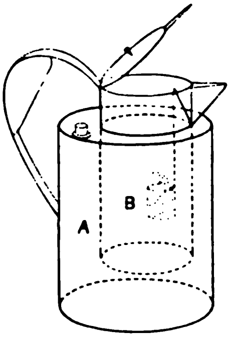
* Journ. Quek. Micr. Club, i. (1884) pp. 327–8.

**Gage's Imbedding-mass Cup.**[*]—S. H. Gage describes the imbedding-mass cup, shown in fig. 43, about 1/5 natural size. A is a water-bath, into the top of which is firmly soldered the cup B for the imbedding-mass, having a fine wire gauze basket, suspended by a stiff wire, for holding the tissue. The cup is placed on one side of the water-bath to facilitate the pouring out of the imbedding-mass. The apparatus may be heated on a stove or by a gas or alcohol flame.

FIG. 43.



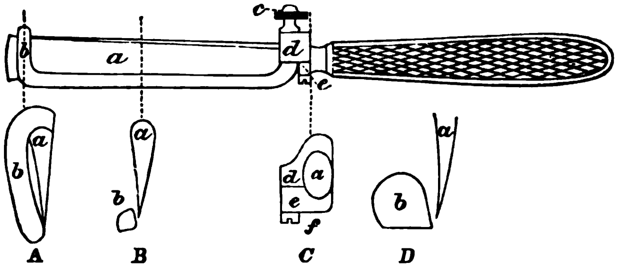
**Gage and Smith's Section-flattener.**[†]—S. H. Gage and T. Smith have devised a section-flattener somewhat similar to that of Andres, Giesbrecht, and Mayer,[‡] but, as they consider, simpler and applicable to every form of section knife.

The section-flattener (fig. 44) consists of a rod *b* of spring brass about 5 mm. in diameter, flattened on two sides *b* and *d*, extending parallel with the edge of the knife, and projecting about 2 mm. beyond it. Opposite the cutting edge the space between the rod and knife is about 1 mm., while nearer the back of the knife the distance is greater (D, *a*, *b*). At each end the rod is bent at right angles. Next the handle it passes through a hollow cylinder *d*, into which it is secured by a milled nut *c*. At the free end of the knife the rod is

[*] Medical Student (N.Y.) i. (1883) pp. 14–16 (2 figs.).
[†] 'The Microscope,' iv. (1884) pp. 25–7 (1 fig.).
[‡] See this Journal, iii. (1883) p. 916.

hooked over the back of the blade A, the spring of the wire securing it firmly. At the two angles of the rod it rests on the blade, so that in cutting sections any amount of pressure may be applied at these points. The rod is attached to the knife by means of a clamp, which consists of two pieces clasping the tang, and held together by a screw *c*. To clean the knife and rod, or to remove sections, the rod may be raised as it swings freely in the hollow cylinder attached to *d*. The rod may be entirely removed, as is necessary in sharpening the knife, by removing the milled nut *c*; the entire apparatus may be removed from the knife by loosening the screw *f*.

FIG. 44.



The section-flattener attached to a section knife:—*a*. Blade of the section knife; *b*. section-flattener; *c*. milled nut; *d*. the part of the clamp bearing the hollow cylinder; *e*. part of the clamp; *f*. screw holding the two parts of the clamp together.

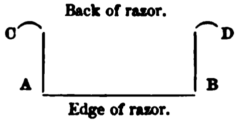
A. Section showing the manner of hooking the section-flattener over the back of the blade.

B and D. Sections showing the form of the section-flattener and its relation to the cutting edge, except at the ends.

C. Section of the tang of the knife, showing the manner of attaching the clamp.

**Francotte's Section-flattener.***—P. Francotte also describes a simple apparatus made by bending an iron wire or knitting needle 1 mm. in diameter into two right angles, the points A and B being 7 to 8 cm. apart.

FIG. 45.



The arms A C and B D are bent into hooks, so as to attach the apparatus to the back of the razor. A C and B D should be of such a length that A B is 0·1 or 0·2 mm. behind the edge.

In cutting, the sections are partially rolled round A B. It is then easy to transfer them to a glass slide and to make them flat, which is generally done without difficulty.

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* Bull. Soc. Belg. Micr., x. (1884) pp. 58–60 (1 fig.).

**Employment of the Freezing Method in Histology.***—Dr. Axel Key and Professor Gustav Retzius reproduce in German an account of the freezing method which had been previously published by them in Swedish. The method is in many cases of great advantage, but it often causes certain abnormal appearances which, without due care, might be taken for actual features in the tissue examined; for example, in fine sections of tendon cut when frozen and fixed afterwards by means of perosmic acid, a series of longitudinal canals were seen; and in sections of brain a regular system of lacunæ communicating with each other appeared to exist which it was quite impossible to demonstrate by means of an injection. All these appearances, in fact, are produced by the freezing method itself; the water contained in the tissues is driven out at the moment of freezing, and collects into lacunæ where there is the least resistance. It is evident, therefore, that the greatest care must be exercised by histologists who make use of this method.

**Improved Method of Using the Freezing Microtome.†**—Prof. W. J. Sollas considers that the process of obtaining thin slices of soft structures by means of imbedding in paraffin has now been brought to a state of almost ideal perfection; on the other hand the method of "freezing" still remains almost in its infancy. At present it is only with great trouble that a continuous series of slices can be obtained with it, and if these are cut from a loose disconnected tissue, they break up immediately on being introduced into water to free them from the gum in which they are always imbedded. Moreover the waste of time involved in transferring from water to a glass slide is simply appalling.

Yet the freezing process has special advantages of its own.

In the case of many tissues it affords a clearer insight into structure; perfect staining is not so indispensable (provided, as is usually the case, glycerine be used as a medium for mounting): and when hard parts occur in a preparation along with soft, both may be evenly cut through with equal ease. It is not likely, therefore, to fall wholly out of use, particularly for certain refined histological work, and improvements may be confidently expected.

The following may perhaps be regarded as a first step to others. Instead of freezing in gum, as is usual, one uses gelatine jelly. This is prepared and clarified in the ordinary manner. It should set into a stiff mass when cold, how stiff will best be learned by experience.

The tissue to be cut is transferred from water to the melted jelly, and should remain in it until well permeated.

It is then placed on the piston of a Rutherford's microtome; the "well" should not be filled, for adherence it is sufficient to roughen the surface of the piston with a file. No more jelly should be used than is sufficient to surround the specimen; if too much has been added, it may be removed when frozen by careful paring.

When well frozen, slices may be cut in the ordinary way; while frozen they should be quickly transferred to the glass slide on which they are to be mounted. On touching the glass, the slice of jelly almost immediately thaws and adheres as a consistent fibre to the surface. When enough slices have been placed on the slide, they should each be covered with a drop of glycerine (the sooner this is added the better); a cover-glass is then superposed, zinc white or some similar cement is run round it, and the preparation is complete. In process of time the glycerine will permeate the gelatine and convert it into glycerine jelly; if this does not take place soon enough, it may be hastened by placing it in an oven kept at a temperature of about 20° to 30° C.

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* Retzius's Biol. Untersuchungen, ii. (1882) pp. 150–3.

† Quart. Journ. Micr. Sci., xxiv. (1884) pp. 163–4.

In this way a series of entire slices of great thinness may be obtained from the most disconnected structures; even when they contain hard silicious spicules, as in the case of sponges.

Diatoms may be cut without difficulty by this method, and the author says he has now beside him some slices of *Pleurosigma* which reveal the internal anatomy of these in an admirable fashion. It need not be added that the process effects a considerable saving in labour and time.

**Mayer's method of Fixing Sections.***—P. Mayer proposes an improvement on the methods of Frenzel, Threlfall, and Schällibaum.

A mixture of equal volumes of filtered white of egg and glycerine is made, and spread with a fine brush in a very thin and uniform layer on a cold slide. The sections are then laid on it, and the whole warmed for some minutes on a water-bath; they can now be treated with oil of turpentine, alcohol, water, and colouring reagents, without any danger of their moving. The glycerine only serves as a means of keeping the surface of attachment moist; if the paraffin in the sections melts, it immediately carries away the albumen, so that the neighbourhood of the section is almost or altogether freed from it, and this is an additional advantage of the method. The mixture of albumen can be kept clear by the use of antiseptics (carbolic acid).

Alum-carmine and strong alcoholized solution of carmine are very useful staining reagents. The latter is slightly modified from the well-known preparation of Gronacher in that 4 gr. of carmine are dissolved in 100 ccm. of 80 per cent. alcohol, with the addition of 30 drops of concentrated pure hydrochloric acid, heated for about half an hour in the water-bath; this solution is filtered, while still hot, and the superfluous acid is carefully removed by the addition of caustic ammonia, added till the carmine begins to be deposited. When quite cold this solution stains very rapidly (for example, embryos of lobsters are stained in about a minute) and intensely, though diffusely; washing in alcohol acidulated with hydrochloric acid is therefore necessary if the nuclei alone are to be stained. The moment of satisfactory cleansing may be judged by the appearance presented by the albumen, which will completely give up the carmine to the alcohol, or will, at most, be only faintly coloured.

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* MT. Zool. Stat. Neapel, iv. (1883) pp. 521-2.

**Gum and Syrup Preserving Fluid.**[*]—The very great objection to the use of freezing microtomes was the impossibility of taking spirit-hardened material and cutting it without an eighteen or twenty-four hours' preparation. Up to a few months ago, any one wishing to cut by freezing had to take his specimens out of spirit, cut them of convenient size, and soak them in water for twelve or more hours to get rid of the spirit, then place them in gum solution some hours further. This was a great drawback, and rendered it a necessity that the operator must think over what he wished to cut, and prepare it through twenty-four hours previously!

All this is changed. Specimens are now kept the year round, if the operator chooses, in gum and syrup, having a little carbolic acid in it, and he freezes and cuts any tissue so placed at any moment he likes.

To make the gum and syrup medium, take of gum mucilage [†] (B.P.) five parts; syrup, [‡] three parts. Add five grains of pure carbolic acid to each ounce of the above medium.

Tissue may remain in this any length of time. For brain, spinal cord, retina, and all tissues liable to come in pieces, put four parts of syrup to five of gum.

The operator will do well to make the gum mucilage and syrup separately, and to keep them so till wanted.

**Cutting Tissues Soaked in Gum and Syrup Medium.**[§]—Take a piece of tissue not more than an eighth of an inch thick, and press it gently between a soft cloth to remove all the gum and syrup from the *outside* of the tissue. Set the spray going, and paint on the freezing-plate a little gum mucilage: then put the tissue upon this and surround it with gum mucilage with a camel-hair brush. The tissue is thus saturated with gum and syrup, but surrounded when being frozen with gum mucilage only. This combination prevents the sections curling up, on the one hand, or splintering from being too hard frozen on the other. Should freezing have been carried too far, the operator must wait a few seconds. It ought to cut like cheese.

**Gum Styrax as a Medium for Mounting Diatoms.**[‖]—Referring to Dr. Van Heurck's recommendation of "styrax," [¶] Mr. F. Kitton writes that the resin which is the product of *Liquidambar orientale* is prescribed in the British Pharmacopœia under the name of gum styrax, and in the drug trade is known as "strained gum styrax." It has the colour of the old-fashioned black treacle, but is of greater consistency; a temperature of 212° renders it fluid. In its commercial state it is unfit for microscopic purposes, first from its impurities, probably owing to the rough method employed in obtaining it—the stems are cut in small pieces and boiled, when the gum rises to the surface, and is skimmed off; and second, from its thickness. It is therefore necessary that it should be dissolved in one of the following menstrua: chloroform, benzol, ether, a mixture of benzol and absolute alcohol. When the resin is dissolved it must be filtered, and it is then ready for use. The solution should be of the colour of brown sherry, and the consistency of limpid olive oil. Its consistency can of course be increased by evaporating a portion of the benzol, and the whole of the latter should be eliminated before placing the cover-glass on the slip. Its refractive index is then 1·63, very nearly that of monobromide of naphthaline. The American liquid-amber is prescribed in the American Pharmacopœia, but seems to be unknown in Europe. It would, if obtainable, be preferable to gum styrax, as its colour is a pale yellow. The colour of the styrax is practically of little consequence, as the film between the cover and slip is very thin, and does not show any appreciable amount of colour when placed under the Microscope.

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[*] Cole's 'Methods of Microscopical Research,' 1884, p. xxxix.

[†] Gum mucilage B.P. is made by placing 4 oz. of picked gum acacia in 6 oz. of distilled water and stirring occasionally until the gum is dissolved. This is to be strained through muslin.

[‡] Syrup is made by dissolving 1 pound of loaf sugar in 1 pint of distilled water and boiling.

[§] Cole's 'Methods of Microscopical Research,' 1884, pp. xxxix.-xl.

[‖] Sci.-Gossip, 1884, p. 66.

[¶] See this Journal, iii. (1883) p. 741.

During the past four or five months Mr. Kitton has used this medium for various Diatomaceæ. The transverse striæ on *Pleurosigma littorale* and the longitudinal on *Navicula cuspidata* are much more sharply defined, and the striæ on all of them are more easily resolved than when mounted in Canada balsam. The most striking difference between gum styrax and Canada balsam is displayed by *Polymyxus coronalis*. In balsam, the valves are perfectly hyaline, and the rays and puncta almost invisible; in gum styrax the valves are light brown, and the markings easily resolved. *Heliopelta*, as might be expected, does not exhibit more structural detail, but every line and dot is more distinct than when it is balsam-mounted. Several of the *Aulisci* are also much improved when mounted in this medium. Mr. Kitton cannot say much of its merits as a medium for mounting other microscopic objects. He has tried it for thin wood sections, hairs, chalk foraminifera, and a few butterfly scales, all of which show better than they do in balsam. The colour of styrax becomes objectionable when a thick layer is necessary. Dr. Van Heurck directs that the commercial gum styrax should be exposed in thin layers to the light and air for several weeks, to eliminate the moisture contained in it previous to dissolving it, but Mr. Kitton has not found this necessary with his sample.

**Mounting Medium of High Refractive Index.***—Professor Hamilton Smith is reported to have mounted *Amphipleura pellucida* and *Navicula rhomboides* in "something having a refractive index of 2·4," the result being "past all expectation, beating everything yet seen," "making a new era in diatom mounting," and "far surpassing all that has been done in phosphorus."

Dr. A. Y. Moore has also † mounted *A. pellucida* in a medium of index 2·3. The appearance of the frustule is said to be "quite remarkable. It can be distinctly seen under a low-power objective under circumstances that a specimen in balsam would be quite invisible." He "has had no difficulty in seeing the dots on the valves with a Spencer 1/10 in. N.A. 1·35, with Beck's vertical illuminator, using lamplight."

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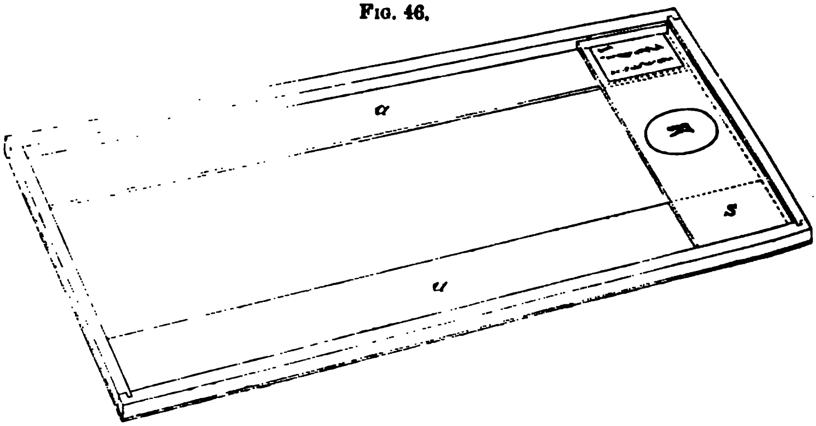
* Journ. Quek. Micr. Club, i. (1884) pp. 333–4.

† Amer. Mon. Micr. Journ., v. (1884) p. 37.

**Kingsley's Cabinet for Slides.***—J. S. Kingsley has had in use for some time a cabinet for holding his preparations, which, while not entirely new, possesses (it is claimed) some original features. It is based upon the model of Dr. Hailes,† but is more compact.

Rectangular frames of light wood are made, measuring inside 3⅛ by 6¼ in., and just the depth of the thickness of a slide (fig. 46).

Fig. 46.



On one side of this strips are glued of four-ply Bristol board *a*, in the manner shown in the figure. These skeleton trays are kept in a box, piled one upon another. By this plan the slides are kept flat, and each one is held in place by the strips of Bristol board, which form the bottom of the tray above it. The preparation and its cover project between these strips; but, as will readily be seen, are prevented from touching the under surface of the slides in the tray above.

The especial advantage claimed for this plan is its compactness, safety, and portability; features of no small importance when one is returning from the sea-shore after the summer's work.

**Pillsbury's Slide Cabinet.**‡—J. H. Pillsbury has devised a cabinet (fig. 47) to allow of a set of slides being taken out and carried to the class-room or the society-room in safety, without being transferred to trays for that purpose and afterwards replaced in the cabinet.

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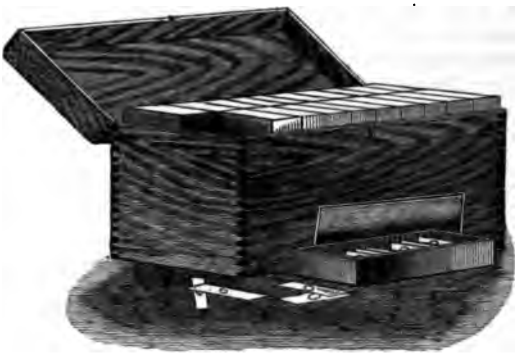
* Science Record, ii. (1884) p. 67 (1 fig.).

† See this Journal, iii. (1883) p. 456.

‡ Science Record, ii. (1883) pp. 25-6 (2 figs.).

Neat, light, and yet firm "trays," each with sawn slots for holding twenty-five slides, are fitted to a polished cherry cabinet in such a way that they stand on end in two rows with sufficient space between the rows to make it convenient to get hold of the trays to take them out. The slides thus lie flat. The upper end of each tray has a printed label with numbered lines for the name of the objects contained in the tray. There is a series of corresponding numbers on the bottom of the box to facilitate the replacing of the slides. This arrangement gives a complete list of the slides in the collection, spread out when the lid of the cabinet is opened, without any handling of the specimens.

FIG. 47.



The slides should be arranged by series, those likely to be wanted for use together being put in the same tray.

**Examining the Heads of Insects, Spiders, &c., alive.***—Mr. E. T. Draper recommends a cone of pasted paper to be made rather larger than the specimen, with the apex cut off. A vigorous spider will soon project its head through the aperture. When in this position it should be blocked behind with cotton wool slightly wetted. The cone can then be gummed to a slip, apex upwards.

Many insects can be arranged in the same way for the observation of facial movements, and such front views admit of interesting and extended study, the action of the antennæ, palpi, and various organs of the mouth may be watched, and curious effects produced by the excitation of saccharine or nitrogenous juices, administered from the top of a sable pencil.

**Examining Meat for Trichinæ.**†—C. Benson describes the following new process for discovering *Trichinæ*:—Slices from 2-3 mm. thick are taken from several different portions of the piece of meat to be examined—by preference from the surface of the flesh. From each is cut a series of thin sections, which are placed together in the following solution:—Methyl-green, 1 gramme; distilled water, 30 grammes. After about ten minutes' maceration, the sections are withdrawn and placed to decolour in a large test-tube filled with distilled water for half an hour, the water being shaken and changed two or three times.

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* Sci.-Gossip, 1884, p. 26.

† Bull. Soc. Belg. de Micr., x. (1883) pp. 24-5.

When the water is very clear, it should be stirred with a glass rod, and on holding the test-tube against the light it is very easy to distinguish with the naked eye the sections containing *Trichinæ*. These present themselves under the form of small, dark-blue, elongated spots, methyl-green staining much more deeply the cysts of the *Trichinæ* than the rest of the tissue.

It is sufficient to examine the sections with a power of 50, and if "no *Trichinæ* are found, one may be absolutely certain that the meat does not contain any."

**Bolton's Living Organisms.**—Mr. T. Bolton continues his praiseworthy efforts to supply microscopists with a variety of living organisms, animal and vegetable. Several which he has sent out were entirely new to science, while others were new to England. His portfolio of drawings has now reached its tenth number. Microscopists subscribing to Mr. Bolton's "bottles," may certainly feel that apart from the practical return which they receive for their subscription, they are doing a real service to microscopy.

**Cole's Studies in Microscopical Science.**—Here, also, great credit is due to the editor, Mr. A. C. Cole, for the exertions which he has made to meet a want that has been felt by microscopists for the last half century. During that time the cry has constantly been that, though slides could be bought in profusion, no guide to their intelligent examination was forthcoming. Mr. Cole supplies weekly, not only a slide with a full description of the object, but also a coloured plate. It will be a matter of very great regret if these "Studies" are allowed to lapse for want of proper support from microscopists.

In addition to the "Studies," Mr. Cole is also publishing in parts, "Popular Microscopical Studies," and "Methods of Microscopical Research."

Alcohol, Absolute, preparing.

["The microscopist can prepare an alcohol which is so nearly devoid of water as to fulfil all ordinary requirements by a very simple process. Ordinary blue vitriol (cupric sulphate) is burnt or calcined until all water of crystallization is expelled and the resulting powder is put into (95 per cent.) alcohol, from which it extracts a large proportion of the water. By repeating the operation several times, an almost absolute alcohol may be obtained."]

*Science Record*, II. (1884) p. 65.

Baumgarten, P.—Beiträge zur Darstellungsmethode der Tuberkelbacillen. (Contributions to the method of demonstrating the bacillus of tubercle.)

*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 51–60.

Bergonzini.—Sull' uso del collodio e del fenolo nella technica microscopica. (On the use of collodion and fennel oil in microscopical technics.)

*Spallanzani Modena*, XII. (1883) Fasc. 4.

Blackham, G. E.—Boxes for Objects. [*Post.*]

*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting (1883) pp. 236–7.

**Bradley's** Mailing Cases. See Pillsbury, J. H.

**Brass**, A.—Die Methoden bei der Untersuchung thierischen Zellen. (The methods for the investigation of animal cells.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 39–51.

**Breckenfeld**, A. H.—A new method of mounting *Hydra*. [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 49–50.

**Browne's** (R., jun.) Case for Objects.
["Each box holds thirty slides in a case that will easily slip into the pocket, and can be set up on the shelf of a bookcase. It has a movable flap-cover over the slides, on which there is a list of numbers so that the slides can be catalogued."]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, 1883, p. 236.

**Calliano**.—Il regolatore del preparato al microscopio. (Guide for microscopical preparation.)
*Giorn. R. Accad. Med. Torino*, XLVI. (1883) Nos. 4, 5.

**Casse**. See Renard, A.

**Cattaneo**, G.—Fissazione, colorazione e conservazione degli Infusorii. (Fixing, colouring, and preserving Infusoria.)
*Bollett. Scientif.*, V. (1883) pp. 89–95.

**Certes**, A.—Analyse micrographique des Eaux. (Microscopical analysis of water.) 8vo, Paris, 1883, 28 pp. and 2 pls. [*Post.*]

Cleaning Slides and Covers.—Letters by F. Dienelt, A. L. W., E. W. Owen, S. Wells, and D. S. W. *Amer. Mon. Micr. Journ.*, V. (1884) pp. 59–60.

**Cole**, A. C.—Studies in Microscopical Science.
Vol. II. No. 11. Sec. I. No. 6. Fibrous Connective Tissue. Plate 6. Areolar Tissue × 40, pp. 21–4.
No. 12. Sec. II. No. 6. Chap. III. The Morphology of Tissues (*continued*), pp. 21–4. Plate 5. Types of Simple Tissues. Plate 6. Prothallus of Fern × 250.
No. 13. Sec. I. No. 7. Fibrous Connective Tissue (*continued*). Tendon, pp. 25–7. Plate 7. Tendon of Lamb T. S. × 70.
No. 14. Sec. II. No. 7. Primary Tissue, pp. 25–8. Plate 7. L. S. through apex of root of Maize (Sachs).
" " Methods of Microscopical Research.
Part VII. Stains and Staining. pp. xli.–iv. [*Supra*, p. 310.]
Part VIII. pp. xlv.–viii. Mounting. (Slides. Covers. Cleaning Covers and Slips. Labels. Transference of Sections. 1. The floating method. 2. Transferring with brushes. 3. By section-lifters.)
" " Popular Microscopical Studies. No. 6. A Grain of Wheat (*continued*). pp. 25–8. Plate 6. Germination of Wheat.

**Day**, F. M.—The microscopical examination of Timber with regard to its strength.
[Title only of paper read before American Philosophical Society, 21st Dec. 1883.]
*Amer. Nat.*, XVIII. (1884) p. 333.

**Dienelt**, F.—See Cleaning.

**Dimmock**, G.—Pure carminic acid for colouring microscopical preparations. [*Post.*] *Amer. Nat.*, XVIII. (1884) pp. 324–7.
" " See Minot, C. S.

**Errera**, L.—See Renard, A.

Fastening Insects and other small forms for dissection.
[In such dissections one occasionally experiences considerable difficulty in fastening the object in the dissecting pan. Pins are inconvenient as they are in the way, and besides they frequently injure portions of the specimen. These difficulties may, however, be avoided by partially imbedding the object in wax or paraffin, which, however, should not extend above the middle line of the body. The paraffin and the imbedded object may then be readily fastened in the dissecting tank, or, when it is necessary to stop operations, the paraffin and object may be placed in alcohol.]
*Science Record*, II. (1884) p. 86.

FEARNLEY, W.—On a new and simple method of applying air-pressure to Wolff's bottles. [*Post.*] *Brit. Med. Journ.*, 1883, pp. 859–60 (2 figs.)

FENNESSY, E. B.—Microscopic.
[A very pretty slide, and one very easily made, is the raphides in the sap of the daffodil. It is only necessary to squeeze out a drop of sap from the flowering stem on to a slide, and on its drying, which may occur spontaneously, or be done over a spirit-lamp, we find hundreds of crystals strewn over the field of view. With the polariscope they are exceedingly interesting and brilliant. If we drop over the warmed glass a little Canada balsam, we can press on a cover-glass.]
*Engl. Mech.*, XXXIX. (1884) p. 34.

FRANCOTTE, P.—Nouveaux réactifs colorants. (New staining reagents.) [*Post.*] *Bull. Soc. Belg. Micr.*, X. (1884) pp. 75–7.

GAGE, S. H., and T. SMITH.—Section-flattener for dry section-cutting.
[*Supra*, p. 314.] *The Microscope*, IV. (1884) pp. 25–7 (1 fig.).

GIERKE, H.—Färberei zu mikroskopischen Zwecken. (Stains for microscopical purposes.) *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 62–100.

GILTAY, E.—Ueber die Art der Veröffentlichung neuer Reactions- und Tinctionsmethoden. (On the mode of publication of new reactions and stains.) *Zeitschr. f Wiss. Mikr.*, I. (1884) pp. 101–2.

GRANT, J.—Microscopic Mounting. VIII. Hardening and Wet Mounting.
[1. Hardening agents; alcohol and chrome solutions; water. 2. The process of hardening.]
*Engl. Mech.*, XXXVIII. (1884) pp. 517–9.

HALL, J.—Preparation of Rock-sections.
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
*Amer. Nat.*, XVIII. (1884) p. 224.

HAMLIN, F. M.—[" Advises the use of crimson lake as a colour for the ground of opaque mounts. When the object is white he considers this better than a black ground, but for objects of different colours he selects a ground which seems to show them best."]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 37.

HAUSHOFER, K.—Beiträge zur Mikroskopischen Analyse. (Contributions to Microscopical Analysis.) [*Post.*]
*SB. K. Bayerisch. Akad. Wiss.*, XIII. (1883) pp. 436–48 (1 pl.).

HITCHCOCK, R.—Microscopical Technic. I. Apparatus and Material. II. Mounting in general.
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 27–31, 51–2.

" " Imbedding Diatoms for making sections. [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 54–5.

INGPEN, J. E.—Remarks on Mounting in Phosphorus.
[An attempt is being made to mount diatoms in absolutely solid phosphorus.]
*Journ. Quek. Micr. Club*, I. (1884) p. 334.

INSLEY, H.—Preparation of Coal.
[Has tried section-making of every kind of fire coal he could get, grinding as thin as possible,—could get no light to pass through the section on account of the presence of so much colouring matter.]
*Midl. Nat.*, VII. (1884) p. 51.

KAIN, C. H.—Some thoughts about Mounting.
[Discussion of various media.—" Some experiments by Mr. E. E. Read, of the Camden Microscopical Society, would seem to indicate that cosmoline may prove a valuable medium in which to mount the starches. The starch-grains are certainly remarkably well displayed in it. How permanent the mounts may prove is a question of time. It is not improbable that several of the petroleum products—even the plebeian kerosene itself—may be found not unworthy of the microscopist's attention."—" Dr. W. W. Munson some time ago called attention to the preservative properties of a solution of hydrate of chloral, and the medium is

evidently deserving of more attention than it has had. A slide of algæ put up in this solution over four years ago still remains as bright and pure as when first mounted, and, what is quite important, the cell contents of the algæ appear to be less contracted than is usually the case."—Cells and Cements.]

*Micr. Bull.*, I. (1884) pp. 9–11.

**Karop**, G. C.—Schering's patent Celloidin for Imbedding. [*Supra*, p. 313.]
*Journ. Quek. Micr. Club*, I. (1884) pp. 327–8.

**Kingsley**, J. S.— A new Cabinet for Slides. [*Supra*, p. 320.]
*Science Record*, II. (1884) p. 67 (1 fig.).

**Kitton**, F.—Glass Cells.
[Directions for perforating thin glass and thick glass slips.]
*Sci.-Gossip*, 1884, p. 41.

" " On Gum Styrax as a medium for Mounting Diatoms.
[*Supra*, p. 318.] *Sci.-Gossip*, 1884, p. 66.

**Marpmann**, G.—Die Spaltpilze. (The Schizomycetes.) 193 pp. and 25 figs. 8vo, Halle, 1884.
[Contains a chapter on "Methods of Research," pp. 107–13.]

**Miles**, J. L. W.—Mounting in Canada Balsam.
[Report of meeting of Mounting Section of the Manchester Microscopical Society. Mentions that a "new cell having alternate elevations and depressions has been devised by a member of the section, in the use of which, by leaving an excess of balsam round the cell and cover-glass, air-bubbles ultimately escape through the spaces and loss by evaporation of essential oil in the balsam is provided for."]
*Micr. News*, IV. (1884) pp. 55–6.

**Minot**, C. S.—Classification of Microscopic Slides.
[Also includes a note on Dr. Dimmock's plan. [*Post.*]
*Science Record*, II. (1884) p. 65.

**Mitchell**, C. L.—Staining with Hæmatoxylon. [*Supra*, p. 311.]
*Proc. Acad. Nat. Sci. Philad.* (1883) pp. 297–300.

**Osborn**, H. F.—Method for Double Injections.
[The veins are first injected through the arteries with coloured gelatine and then a differently coloured plaster of Paris is injected in the same way, forcing the gelatine before it, but as this stops at the capillaries, the arteries and veins can readily be distinguished.]
*Science Record*, II. (1884) p. 84.

**Owen**, E. W.—See Cleaning.

**Pillsbury's** (J. H.) New case for Mailing Slides. [*Post.*]
*Science Record*, II. (1884) p. 86 (2 figs.).
*Micr. Bull.*, I. (1884) p. 12 (2 figs.).
*The Microscope*, IV. (1884) p. 41 and Advt. i. (2 figs.).

**Prinz**, W.—See Renard, A.

**Queen's** (J. W. & Co.) Slides of Animal Hairs and Fibres (textile). Vegetable Esculents and Adulterations. *Micr. Bull.*, I. (1884) p. 13.

**Rasmussen**, A. F.—Om Dyrkning af Mikroorganismer fra Spyt af sunde Mennesker. (On the culture of Micro-organisms from the sputum of healthy men.) 136 pp. and 2 pls. 8vo, Copenhagen, 1883.

**Renard**, A., L. **Errera**, **Casse**, and W. **Prinz**.—Discussion on the present condition of Physiological Chemistry and the advantage of the employment of Microchemical methods.
*Bull. Soc. Belg. Micr.*, X. (1884) pp. 67–9.

**Schaarschmidt**, J.—Ueber die Mikrochemische Reaction des Solanin. (On the Microchemical Reaction of Solanin.)
*Zeitschr. f. Wiss. Mikr.*, I. (1884) p. 61–2.

**Sharpe**, B.—Various methods of Carmine Staining.
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
*Amer. Nat.*, XVIII. (1884) p. 224.

SLACK, H. J.—**Pleasant Hours with the Microscope.**
[Commensalists—Symbiosis—Lichens and the Schwendenerian Theory. [Trachelomonads and *Amœbæ*] [*Astasia trichophora*] [Flower and Pollen of Hazel, Gymnosperms, &c.]
*Knowledge*, V. (1884) pp. 82–3 (1 fig.), pp. 109–10 (2 figs), pp. 141–2 (6 figs), pp. 182–3 (2 figs.).

SMITH, T.—See Gage, S. H.

SMITH, W. D.—**New modification of a Turntable.**
[An attempt to unite in one piece of apparatus the most valuable points in Kinne's and Dunning's instruments. It consists of a circular brass plate, on the under side of which is a lever having its fulcrum on the axle of the table. This lever moves two arms which work in slots cut in the plate so that they always approach or recede from the centre in an exactly equal degree. The arms carry on the upper side of the plate two flat pieces of brass 2 in. in length, which grasp the slide, one of these being fixed at right angles to the slot, and the other pivoted so as to be able to adjust itself to the slide, as in Dunning's instrument.]
*Journ. Quek. Mikr. Club*, I. (1884) p. 31.

SMITH'S (H.) **new Mounting Medium.** [*Supra*, p. 319.]
*Journ. Quek. Mikr. Club*, I. (1884) pp. 333–4.

SOLLAS, W. J.—**An improvement in the method of using the Freezing Microtome.**
[*Supra*, p. 316.] *Quart. Journ. Micr. Sci.*, XXIV. (1884) pp. 163–4.

STILLSON, J. O.—**Cabinet for Objects.** [*Post.*]
*Proc. Amer. Soc. Micr.*, 6th Ann. Meeting, 1883, p. 237.

STRENG, A.—**A new Microchemical Test for Sodium.**
*Jahrb. f. Mineral.*, 1883, II., Ref. p. 365.
See *Journ. Chem. Soc.*—Abstr., XLVI. (1884) pp. 366–7.

UP DE GRAFF, T. S.—**Measuring Blood-corpuscles.**
[Remarks on C. M. Vorce's article and R. Hitchcock's comments, *ante*, p. 159.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 26–7.

W., A. L.—See Cleaning.

W., D. S.—See Cleaning.

WELLS, S.—See Cleaning.

WHITE, T. C.—**Method of preparing Sections of Hard Tissues.**
[First "Demonstration" of the second series, with remarks by J. E. Ady on preparing and mounting sections of teeth and bone, *supra*, p. 304.]
*Journ. Quek. Micr. Club*, I. (1884) p. 330–2.

WILSON, E. B.—**Methods of Section-cutting.**
[Title only of paper read at meeting of Society of Naturalists of the Eastern United States.]
*Amer. Nat.*, XVIII. (1884) p. 224.

WRIGHT, L.—**Mounted Insect Preparations.**
[Commendation of A. Topping's preparations.]
*Engl. Mech.*, XXXIX. (1884) p. 34.

ZENTMAYER'S (J.) **new Centering Turntable.** [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 23 (1 fig.).

# PROCEEDINGS OF THE SOCIETY.

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**ANNUAL MEETING OF 13TH FEBRUARY, 1884, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (PROF. P. MARTIN DUNCAN, F.R.S.) IN THE CHAIR.**

The **Minutes** of the meeting of 9th January last were read and confirmed, and were signed by the President.

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The **List of Donations** (exclusive of exchanges and reprints) received since the last meeting, was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Owen, R.—On Parthenogenesis. 76 pp. and 1 pl. 8vo, London, 1849.<br>Siebold, C. T. E. v.—On a True Parthenogenesis in Moths and Bees. (Translated by W. S. Dallas.) viii. and 110 pp. and 1 pl. 8vo, London, 1857. .. .. .. .. .. .. .. | *Mr. Crisp.* |
| 6 Slides of Crystals of Uric Acid, from Lepidoptera .. .. | *Mr. C. M. Vorce.* |

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The **Report of the Council** was read by Mr. Crisp (see p. 329).

The adoption of the Report was moved by Mr Glaisher, who congratulated the Society upon its extremely satisfactory nature, and having been seconded by Mr. Michael, was put to the meeting and carried unanimously.

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The **Treasurer** (Dr. Beale, F.R.S.) read his Statement of the Income and Expenditure of the Society for the past year, which showed that more than 750*l.* had been received from Fellows.

The adoption of the Treasurer's Statement was moved by Mr. Glaisher, who said that he regarded it as one of the most pleasing facts connected with the Society that they were progressing in the manner shown by these reports, and he urged upon every Fellow of the Society to do all that could be done to still further advance their position so as to place them in the first rank amongst Societies.

Dr. Millar seconded the motion, which was put and carried unanimously.

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The **List of Fellows** proposed as Officers and Council for the ensuing year was read as follows :—

*President*—*Rev. W. H. Dallinger, F.R.S.

*Vice-Presidents*—*John Anthony, Esq., M.D., F.R.C.P.L.; *Prof. P. Martin Duncan, M.B., F.R.S.; James Glaisher, Esq., F.R.S., F.R.A.S.; Charles Stewart, Esq., M.R.C.S., F.L.S.

*Treasurer.*—Lionel S. Beale, Esq., M.B., F.R.C.P., F.R.S.

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* Have not held during the preceding year the office for which they are nominated.

*Secretaries*—Frank Crisp, Esq., LL.B., B.A., V.P. & Treas. L.S.; Prof. F. Jeffrey Bell, M.A., F.Z.S.

*Twelve other Members of Council*—A. W. Bennett, Esq., M.A., B.Sc., F.L.S.; *Robert Braithwaite, Esq., M.D., M.R.C.S., F.L.S.; *G. F. Dowdeswell, Esq., M.A.; J. William Groves, Esq.; John E. Ingpen, Esq.; John Matthews, Esq., M.D.; John Mayall, Esq., jun.; Albert D. Michael, Esq., F.L.S.; John Millar, Esq., L.R.C.P., F.L.S.; *William Millar Ord, Esq., M.D., F R.C.P.; *Urban Pritchard, Esq., M.D.; William Thomas Suffolk, Esq.

Mr. Curties and Mr. Crouch having been appointed Scrutineers by the President, the ballot was proceeded with, and the Scrutineers having handed in their report of the result, the President declared the Fellows who had been nominated to be duly elected as Officers and Council for the ensuing year.

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The President then read his Address (see p. 173), in which he dealt principally with low-power objectives, congratulating the Society upon the great progress which had taken place since his first address in the comprehension of the subject of aperture and in the use of the numerical aperture notation.

Dr. Anthony said that the pleasing duty devolved upon him of returning thanks to the President for his address. He would also add to this the thanks of the Society for his three years' services as their President. He did not have the pleasure of personally hearing the previous addresses, but he read them with charm in the Journal (as he hoped to read the one they had just heard); indeed, the first one he had not only read once but three times, and thought he might say he had not done with it yet. He had that evening had the pleasure of hearing some things which he knew before but which had been placed in a new light; but in addition to these there was much which he did not know, and he might refer especially to the interest of the remarks as to the Bacteria. He would venture also to recognize warmly the admirable manner in which the President had met all with whom he had come in contact, and his able conduct in the Chair. If he might be allowed to use a simile, he might say that the versatility of the President's qualifications reminded of the mighty power of a Nasmyth's hammer, which while it was able to shape a ton of glowing metal could nevertheless be made to crack a single nut. He had great pleasure in proposing a vote of thanks to the President for the address and for the able manner in which he had fulfilled the duties of his office during the last three years.

Mr. Crisp, in seconding the motion, said that in his experience they never had a President who had given more attention to his duties or who had been more ready to advance the Society's interests, whilst at their meetings he was always ready to deal with whatever subject might be before them, and to throw light upon it.

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* Have not held during the preceding year the office for which they are nominated.

Dr. Anthony having put the proposition to the meeting, it was carried by acclamation.

Prof. Duncan, in thanking the Fellows for the very warm manner in which the vote of thanks had been received, said they could perhaps hardly realize what a feeling of satisfaction arose in his mind when he found that they were parting from each other under such very gratifying circumstances. Throughout his triple term of office nothing disagreeable had ever happened, and as to their general prosperity, the state of their finances would afford conclusive proof as to that, apart from the fact that no less than 143 Fellows had been elected during the three years. With regard to his successor he could only say that he believed that they would find the Rev. Mr. Dallinger a most admirable President, and one well qualified in every way to fill the position to which he had been elected.

**The following Instruments, Objects, &c., were exhibited:—**

Mr. T. Bolton:—*Bacillaria paradoxa.*

Mr. F. R. Cheshire:—Inosculating Muscular Fibres from the dorsal vessel of *Apis mellifica* (third segment).

Mr. Crisp:—

(1) Hirschwald's Goniometer Microscope.
(2) Nelson's Student's Microscope.
(3) Pringsheim's Photo-chemical Microscope.
(4) Schieck's Corneal Microscope.

Mr. Rosseter:—*Stephanoceros Eichhornii.*

Mr. C. M. Vorce:—Crystals of Uric Acid from Lepidoptera.

**New Fellows**:—The following were elected *Ordinary* Fellows:—Messrs. William H. Bates, M.D., John Bennett, William E. Damon, Richard L. Mestayer, A.S.C.E., John Morley, and William Wales.

## REPORT OF THE COUNCIL FOR 1883.

*Fellows.*—The number of new Ordinary Fellows elected during 1883 was 53, as against 40 in 1882. After deducting 28 Fellows (2 of whom were compounders) who have died or resigned, this leaves a net increase of 25 for the year, and an addition to revenue of 44*l.* 2*s.* per annum.

Of the Honorary Fellows, Dr. F. Pacini died during 1883, and in his place was elected Dr. H. van Heurck, of the Botanical Gardens, Antwerp, well known as a microscopist and for his excellent synopsis of Belgian diatoms.

The list now includes 551 Ordinary, 50 Honorary, and 83 Ex-officio Fellows, or 684 in all.

The Council are of opinion that, under existing circumstances, the subscription of Foreign Fellows is too low. For a payment of 21*s.* per annum Fellows residing abroad, within the limits of the Postal

## Dr. THE TREASURER'S ACCOUNT FOR 1883. Cr.

| 1883. | £ | s. | d. |
|---|---|---|---|
| To Balance brought from 31st December, 1882.. .. | 208 | 18 | 0 |
| „ Interest on Investments .. .. .. .. .. .. .. | 89 | 12 | 5 |
| „ Admission Fees .. .. .. .. .. .. .. ..<br>„ Annual Subscriptions .. .. .. .. .. .. .. | 712 | 5 | 0 |
| „ Compositions .. .. .. .. .. .. .. .. .. .. | 56 | 14 | 0 |
| „ Journals and Reprints sold by Assistant-Secretary | 4 | 6 | 6 |
| „ Screw tools sold.. .. .. .. .. .. .. .. .. .. | 2 | 17 | 4 |
| „ Difference in rate of Exchange (Foreign Remittance) | 0 | 4 | 0 |
| | £1074 | 17 | 3 |

| 1883. | £ | s. | d. |
|---|---|---|---|
| By Rent, Gas, and Attendance .. .. .. .. .. .. | 96 | 13 | 0 |
| „ Salaries, Reporting, and Commission .. .. .. | 141 | 2 | 6 |
| „ Books and Binding .. .. .. .. .. .. .. .. | 27 | 5 | 0 |
| „ Expenses of Journal, 1882 .. .. .. .. .. .. | 80 | 0 | 0 |
| „ „ „ 1883 .. .. .. .. .. .. | 400 | 0 | 0 |
| „ Stationery and Miscellaneous Printing.. .. .. | 9 | 1 | 9 |
| „ Coffee at Evening Meetings .. .. .. .. .. .. | 17 | 7 | 0 |
| „ Fire Insurance .. .. .. .. .. .. .. .. .. | 1 | 4 | 0 |
| „ Cheque Book and Commission .. .. .. .. .. | 0 | 5 | 6 |
| „ Petty Cash and Postage of Journal .. .. .. | 88 | 14 | 4 |
| „ Subscription to Mr. Bolton's Bottles .. .. .. | 2 | 2 | 0 |
| „ „ Mr. Cole's Slides .. .. .. .. | 4 | 4 | 0 |
| „ Balance remaining 31st December, 1883 .. .. | 206 | 18 | 2 |
| | £1074 | 17 | 3 |

L. S. Beale, *Treasurer.*

*Investments*, 31*st December*, 1883.

1200*l.* Freehold Mortgages. 1057*l.* 13*s.* 3*d.* Three per cent. Consols (including 100*l.* Quekett Memorial Fund).

The foregoing Annual Account examined and found correct, February 1st, 1884.

Philip J. Butler } *Auditors.*
Robert Kemp

Union, receive the Journal post-free, or an equivalent of 32*s*. The Council recommend that after the present year (1884) the annual subscription for Foreign Fellows should not be less than 31*s*. 6*d*.

*Revenue*.—With the additions to the number of Ordinary Fellows, the income of the Society has continued to increase, and the report of the Treasurer, showing a total receipt of 866*l*., is the most satisfactory report which the Society have ever had placed before them.

*Library*.—Mr. Reeves having tendered his resignation as Librarian and Assistant-Secretary, the Council took into consideration the question of recognizing his long services to the Society, and resolved to recommend to the Annual Meeting a grant to him of 100*l*. out of the capital funds of the Society.

The Council selected, as Mr. Reeves' successor, Mr. James West, previously assistant in the library of the Linnean Society, and have arranged that in future the Library, in place of being open from 11 to 4 as formerly, shall be open from 10 to 5.

*Journal*.—The Journal for 1883 contained 1000 pages, the exact limit fixed by the Council. The index has been further improved by including in it the names of all authors whose names appear in the Bibliographical lists, so that a reference to the index will alone be necessary to find any paper noted during the year. In other respects the Journal has been continued on the same basis as before, and every care has been taken to insure that no paper or article of any importance in Microscopy shall escape notice in the pages of the Journal.

The sales of the Journal have steadily increased notwithstanding the augmentation in price, and of the second or current series only 17 sets remain. This places no little difficulty in the way of a satisfactory adjustment of the Exchange List, which must necessarily be still further curtailed so as to insure at least 25 sets being in future left in the Society's hands. The Council have been reluctant at present to increase the number printed, as they have felt it desirable to limit as much as possible the expense of the Journal in view of the probability of having to engage a paid editor on Mr. Crisp relinquishing the honorary editorship.

*Papers*.—The papers read during the year have been of considerable interest, and have embraced a variety of subjects, including Dr. Hudson's on "New *Floscularia*" and a "New *Asplanchna*," Mr. Matthews' on the "Red Mould of Barley," Prof. Abbe's on "The Relation of Aperture to Power," Mr. Lovett's on "Preparing Embryological and other Delicate Organisms," Mr. Michael's on "The Anatomy of the Oribatidæ," Mr. Stearn's on "The Use of Incandescence Electric Lamps," Mr. Waddington's on "The Action of Tannin on the Cilia of Infusoria," Messrs. Morris and Henderson's on "The Ringworm Fungus," Mr. Beck's on "Cladocera of the English Lakes," Mr. Squire's on a "Method for Preserving the Freshwater Medusæ," and others by Prof. Bell, Mr. Crisp, Mr. Dowdeswell, Dr. Maddox, and Dr. Schröder.

### MEETING OF 12TH MARCH, 1884, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (THE REV. W. H. DALLINGER, F.R.S.) IN THE CHAIR.

**Mr. Glaisher** said he had great pleasure that evening in introducing to the Fellows their new President, the Rev. W. H. Dallinger, F.R.S., whose name was so familiar to most of them, and whose work in a difficult branch of microscopical research was so well known. He begged therefore, on behalf of the Fellows of the Society, to offer a most hearty welcome to Mr. Dallinger, on the occasion of his taking his seat in the Presidential chair for the first time.

The Rev. W. H. Dallinger (who on rising was received with cheers) said that it was with very considerable pleasure that he occupied that evening the honourable position to which they had elected him, and he thanked them sincerely for the kind manner in which they had received the remarks of Mr. Glaisher. In coming amongst them as their President, he confessed to feeling a certain amount of trepidation, which arose in part from the newness of the position to which he had been elected, partly from the fact of his but slight personal acquaintance with so many of the Fellows of the Society (although he was well acquainted with many by name), but chiefly from the consciousness that he was succeeding a President who was in so many ways better qualified to fill the position, and whose admirable conduct as their President during the past three years was so well known and so cordially acknowledged by all. As they were no doubt aware, his own work with the Microscope had been special rather than general; he might say that he had taken a small corner of a very large field and had endeavoured to work it thoroughly. Whilst, however, endeavouring to become more or less master of the special point which he had made his study, he had not allowed anything of importance which concerned microscopy to escape notice, though doubtless there were many points to which he had not devoted particular attention. Although, therefore, it was possible that he might not be very pronounced on some points, his interest in the Microscope was of the deepest kind, and his strong desire was that the instrument, whether used by the youngest student or by the advanced observer, should be scientifically employed, and that every effort should be made to render it more than ever a means of promoting true research.

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**The Minutes** of the meeting of 13th February last were read and confirmed, and were signed by the President.

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**The List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| 7 vols. of the publications of the Palæontographical Society | *Mr. Crisp.* |
| 2 Slides of Sticklebacks .. .. .. .. .. .. .. .. .. | *Mr. J. Norman, jun.* |

**Mr. John Mayall, jun.**, exhibited Mr. Nelson's microscope lamp, embodying several modifications and improvements which he had suggested should be made in it since its original introduction. The body of the lamp was now fitted with a rack and pinion movement by which it could be easily raised or lowered, and a slight alteration enabled the burner to be brought down 3/4 in. nearer to the table than before. An adjustable slot diaphragm plate had been made to fit in front of the glass of the lamp, and an extra groove had been provided in which tinted glass might be placed. The cylindrical part of the metal chimney was now made so that an opal glass reflector could be inserted if desired.

The President said he was struck with the description of the lamp in its original form which had appeared in the Journal of the Society, and he was very desirous of examining it further. The ability to lower the lamp so much was a most useful feature, the fault of most lamps being that they could not be brought low enough for many purposes.

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**Mr. E. Ward's** new cells, devised by Mr. Wilks for mounting without pressure in Canada Balsam, were exhibited (see p. 325).

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**Herr E. Böcker's** improved form of freezing microtome was exhibited by Mr. J. Mayall, jun.

Mr. J. W. Groves said that the diagonal motion given to the knife was very ingenious. There was also an ingenious automatic arrangement by which the specimen was raised after making each cut so as to be in position for the next section. A screw adjustment enabled the thickness of the sections to be controlled, and when once set, any number of consecutive sections could be cut of the same thickness by simply repeating the movement of the razor.

Mr. Crisp, in reply to a question from Mr. Michael, referred to the description given in the Journal of the instrument in its original form, and read extracts therefrom.

Mr. Beck said that he thought the object in introducing a new piece of apparatus should be increased simplicity of construction, and he should like to know if it was claimed that the new microtome could cut a section very much better than any other, because if not he hardly saw what utility there was in introducing it. Any one who was in the habit of cutting thin sections would be aware how very inconvenient it was to have to wipe up and clean a complicated instrument, as compared with a more simple one. Those who had much practical experience of section cutting knew that the difficulty lay more with the substance to be cut, as to its condition, freshness, hardness, &c., than with the instrument with which they cut it.

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**Mr. Crisp** mentioned with regret that since their last meeting they had received an intimation of the death of Mr. Charles Stodder, of Boston, who had always been very kind and courteous in his relations with the officers of the Society.

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Mr. E. H. Griffith's note on a multiple eye-piece was read by Mr. Crisp, and his diagram in illustration enlarged upon the board. Mr. Griffith proposes to set the different eye-lenses in a revolving disk with projecting milled edge, the diaphragm with different sized apertures being arranged in the same way. A draw-tube is provided to vary the length of the eye-piece.

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Mr. Crisp read the following letter which had been received on behalf of a Microscopical Society of Ladies at San Francisco:—

San Francisco, Cal., Jan. 14, 1884.

DEAR SIR,—I have the honour to announce to you that at the instance of Prof. Henry G. Hanks, our State Mineralogist, we in the summer of 1882 moved in the matter of the organization of a Microscopical Society, whose membership should consist entirely of women. August 10th, 1882, a few ladies joined me in my class-room (I am a teacher in the Girls' High School of this city), and together we organized a Society to be known as the California Microscopical Society. We elected Mrs. Mary W. Kincaid our President. Aug. 20th, 1883, we incorporated our Society under the laws of California, and re-elected Mrs. Kincaid as President. Now, in 1884, at the suggestion of Mr. Hanks, we formally announce ourselves to you.

We have twenty-five members, the use of several fine instruments, are interested in our work, and hope to increase both our numbers and usefulness.

Mr. Hanks says that so far as he is aware, the California Microscopical Society is the only one in the world whose membership consists entirely of women.

Trusting that you may be pleased to extend us a word of cheer,

We remain very truly yours,

MARY L. HOFFMAN,

Secretary C.M.S.

Frank Crisp, Esq., F.R.M.S., London.

Mr. Beck presumed that this letter would be suitably acknowledged and entered upon the minutes. He was very glad to hear of this Society's existence, for there was a very wide field in which ladies could work most efficiently and for which their manipulative skill particularly fitted them.

The President said it was quite in harmony with the subject to mention that a notice was that evening given for the next meeting of the Council as to ladies being admitted into this Society.

Mr. Crisp said that there was one other Ladies' Microscopical Society already in existence—the Wellesley College Society.

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Mr. John Brennan's letter as to his discovery of the nature of the potato blight was read.

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**Mr. Crisp** exhibited Schieck's No. 8 Microscope in which a fine adjustment was obtained by tilting the stage at one end. This plan had been commented upon unfavourably at one of the meetings of the Society some years back, but it was pointed out in answer by some German writers that sufficient attention had not been given to the fact that it was only applied to quite cheap forms of stand. High powers would not be used with these stands and therefore the deviation of the stage from a plane would be hardly perceptible, and it was alleged that no better form of fine adjustment could be found without departing from the essence of the problem, i. e. maintaining the low price of the instruments.

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**Col. O'Hara's** further communication on some peculiarities of form in blood-corpuscles, with five enlarged photographs, was read.

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**Mr. Rosseter's** paper "On an Annular Muscular Formation in *Stephanoceros Eichhornii*" was read.

Mr. Crisp said that the authorities whom he had consulted on the subject, including Dr. Hudson, had not observed any such circular muscles in a rotifer as were drawn by Mr. Rosseter, though they were not prepared to say such a *lusus naturæ* was impossible. Dr. Hudson thought it remarkable how experts differed. Ehrenberg as well as Rosseter gave four pairs of muscles in *Stephanoceros*. Gosse gives five, while he (Dr. Hudson) considers there are six pairs, one pair being almost invariably hidden from view, whichever position of the animal happens to be caught. It can be readily understood how, if a glass tube had lines ruled down its length, some (at the sides of the field of view) would always be projected on each other, and confounded with the two edges.

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**Mr. Massee's** paper "On the Function and Growth of Cells in the genus *Polysiphonia*," was read by Prof. Bell (see p. 198).

Mr. Bennett thought that the great interest attaching to this paper was the illustration which it afforded of the continuity of protoplasm. The slides exhibited required, however, a higher power than was applied to them under the Microscope upon the table, in order to demonstrate the fact of their absolute continuity, but he might say that he had subjected them to examination with the highest powers, and could find no break in the continuity. Botanists would, he thought, be agreed that this theory of the continuity of protoplasm was without doubt the most important discovery of its kind which had been made of late years. Prof. Percival Wright, of Dublin, was the first to call attention to it, and from the observations of others who had followed, it seemed clear that the old idea that the cell was an element in itself, would have to be abandoned. The discovery was also of the greatest importance in explaining the irritability of the organs of plants, such as the leaves of the *Mimosa*, and he could only express a hope that the further attention called to the subject by this paper would lead to more conclusive evidence being obtained.

Mr. Groves said he had lately tried to repeat Mr. Gardiner's experiments, but found at first a good deal of difficulty. He had, however, been more successful by treatment with dilute sulphuric acid, and then staining the cells, by which means he proved most conclusively that the cells were connected with each other. In reply to a question from Mr. Bennett, he stated that he had experimented with different parts of *Geranium*, *Vallisneria*, and other plants, and had been successful in every case.

Prof. Reinsch's paper on "Bacteria and Microscopic Algæ on the surface of Coins in currency," was read by Mr. Crisp, in which the author described the constant presence of large numbers of different species of bacteria and algæ on all silver and copper coins which have been several years in currency.

The President said that in the form in which these facts were presented, they were new to him, but he did not think the subject was in itself wholly new, for it had been observed by others that similar organisms existed on tool handles, such as pliers, &c. By taking off the slight deposit found in the cross lines, or on the handle of an engraver's tool, or of a saw, and putting it into water, an abundant supply of bacteria could be obtained. Whether those described were indigenous to the copper, or whether they were simply there as desiccated forms of deposited putrefactive organisms, he was unable to say, though he thought the latter to be the more likely.

Prof. Abbe's note "On the Distance of Distinct Vision" was read by Mr. Crisp, and discussed by Mr. J. Mayall, junr., Mr. Beck, and Mr. Crisp.

The following Instruments, Objects, &c., were exhibited:—

Herr E. Böcker:—Improved Freezing Microtome.

Mr. J. Cheshire:—Ovary of *Apis mellifica* (hive bee) showing the spermatheca at the junction of the oviducts.

Mr. Crisp:—(1) Schieck's No. 8 Microscope. (2) Watson's Revolving Stage. (3) Collins' Set of Fish Scales. (4) Section of Hydroid Polyp with extended tentacles (by Mr. E. Ward).

Mr. Massee:—Two slides illustrating his paper, and showing the continuity of protoplasm in *Callithamnion* and *Ptilota*.

Mr. J. Mayall, jun.:—Improved Nelson-Mayall Lamp.

Mr. E. Ward: (1) Wilks' Cells, for mounting without pressure in balsam; (2) 2 slides of young Sticklebacks.

**New Fellows.**—The following were elected *Ordinary* Fellows:—Messrs. Frank E. Beddard, M.A., J. P. McMurrick, M.A., John Potts, T. B. Redding, William Tarn, John Terry, and W. H. Walmsley.

Fig. 1.

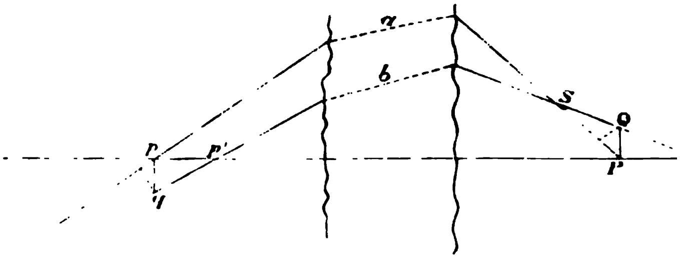


Fig. 2.

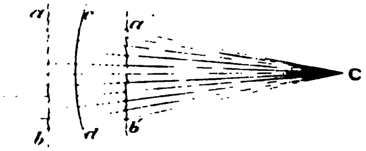


Fig. 3.

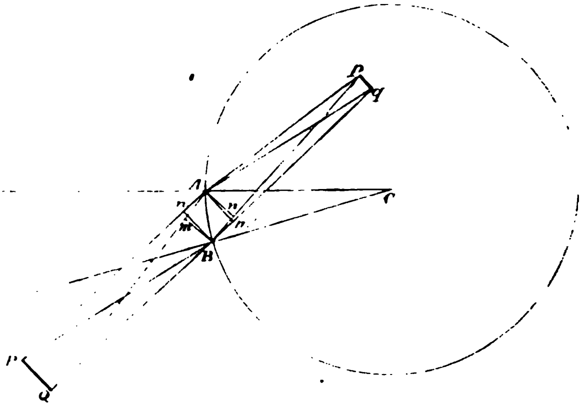
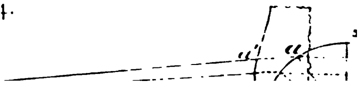


Fig. 4.



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## TRANSACTIONS OF THE SOCIETY.

### VIII.—*On the Estimation of Aperture in the Microscope.*

By the late CHARLES HOCKIN, jun.[*]

(*Read* 14*th June*, 1882.)

PLATE VII.

I HAVE read with much interest the papers by Prof. Abbe and Mr. Crisp on the aperture of Microscope objectives, in which is shown the great increase in aperture obtained with immersion over dry objectives.

It is not a little strange that at a date so long subsequent to the introduction of immersion objectives, any microscopist should be found maintaining that it is impossible for an immersion objective to have an aperture in excess of that of a dry objective of 180°. As, however, this has been asserted (and apparently seriously), it may be worth while to add a few observations to those contained in the papers referred to, the form in which Professor Abbe has put both his definition of numerical aperture and also his proof of the identity of his formula for numerical aperture with his definition, allowing of further elucidation, and from a somewhat different point of view.

Professor Abbe defines the numerical aperture of an objective as "the ratio of the linear semi-opening to the focal length." This ratio is expressed in his notation by $n \sin u$, where $u$ is half the aperture-angle of the objective, and $n$ the refractive index of the medium in which the object is placed. In the proof of the identity of the formula $n \sin u$ with the definition, Professor Abbe has been as concise as possible, referring to other works for the demonstration of all those formulæ of which he has need, which have been already published; so that the exact sense of the terms used in the definition comes out only in the course of the demonstration.

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[*] This paper has been delayed in publication in consequence of the lamented death of the author, and the want of two of the diagrams, now supplied. The late Mr. Charles Hockin, jun., was an electrician and mathematician of considerable repute, and was a high Wrangler of his year.

Professor Abbe remarks that his expression for aperture represents the "number of rays," and not only the amount or "mere quantity of light" admitted by the objective and utilized for the formation of the image. The "number of rays" and "quantity of light" are distinguished in the course of his demonstration, as I understand it, by the fact that the first is measured in one dimension of space, and the second in two dimensions.*

Prof. Abbe's definition of aperture may, I think, be treated as a strictly photometrical one, and that it expresses the relation of the total amount of light utilized by an objective of given magnifying power in an axial plane to the total amount of light emitted by an object supposed to be *in air* and *under a fixed illumination.*

The object is also supposed to be a small portion of a plane surface.

That this is the case appears from the assumption made by Prof. Abbe that the pencils of light of *small* angular aperture, which proceed from the objective to the image, are properly measured by their breadth at a fixed distance from their point of convergence. This assumption involves evidently the condition that the pencils of light in question have the same intensity over their breadth, and this condition is fulfilled approximately only if the object is nearly plane.

All this will appear, perhaps, more clearly in the course of the following demonstration which, following the lines of Prof. Abbe's proof, is somewhat more detailed, and supplies demonstrations of certain of the formulæ which Prof. Abbe omits as too well known to require further illustration.

*Lemma.*—An instrument collects all the rays that emanate from *some one point* in its axis in front of the instrument (and which are contained within a certain finite angle), and causes them to converge accurately to a point in its axis at the back of the instrument, and further collects, under similar restrictions, all rays from a second point in front of the instrument, indefinitely near the first and situate in a plane normal to the axis of the instrument and passing through the first point, and causes them also to converge accurately to a second point behind the instrument, lying in a plane normal to the axis, and passing through the point of convergence of rays incident from the first point.

Then the sine of the angle that any ray incident on the instrument from the first point mentioned makes with the axis, bears a constant relation to the sine of the angle that the corresponding emergent ray makes with the axis.

Let P, Q be the foci of incident and $p$, $q$ the corresponding foci of emergent rays; P Q and $p\,q$ being indefinitely small (Plate VII. fig. 1).

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* [See Note by Prof. Abbe, *infra*, p. 346.—Ed.]

Let P S $p$ $s$, Q S $q$ $s$ represent the course of two rays through the instrument, and let $n$, $n'$ be the refractive indices of the media in which P Q and $p\,q$ respectively lie.

Then because every ray from P passes through $p$ we must have

$$n\,.\,\mathrm{PS} - \overline{\mathrm{S}as} - n'ps = \text{a constant for every ray through P};$$

also

$$n\,.\,\mathrm{QS} - \overline{\mathrm{S}bs} - n'qs = \quad ,, \qquad ,, \qquad ,, \qquad \mathrm{Q}.$$

Here $\overline{\mathrm{S}as}$ and $\overline{\mathrm{S}bs}$ represent the "reduced path" of the rays between S and $s$, or the sum of the product of the lengths traversed in each medium they pass through by the refractive index of each medium.

Again $\overline{\mathrm{S}as} = \overline{\mathrm{S}bs}$ because these two rays start from and end at the same point and make an indefinitely small angle with each other.

$$\therefore \quad n(\mathrm{PS} - \mathrm{QS}) - n'(ps - qs) = \text{constant},$$

or, in the limit, if $u$, $v$ are the angles that S P and $s\,p$ make with the axis,

$$\begin{aligned} n\,.\,\mathrm{PQ}\sin u - n'pq\sin v &= \text{constant} \\ &= 0 \text{ because } u \text{ and } v \text{ vanish together.} \end{aligned}$$

Again, if N is the magnifying power of the instrument,

$$pq = \mathrm{N}\,.\,\mathrm{PQ}$$

and

$$n\sin u - n'\mathrm{N}\sin v = 0$$

$$\frac{\sin u}{\sin v} = \frac{n'\mathrm{N}}{n} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad \mathrm{A}.$$

Had we assumed that rays from P converged to $p$, and that rays from P′ converged to $p'$ where P′ and $p'$ are points near P and $p$, but situate in the axis, we should have found

$$\frac{\sin\frac{u}{2}}{\sin\frac{v}{2}} = \sqrt{\frac{\mathrm{M}\,n'}{n}} \quad . \quad . \quad . \quad . \quad . \quad . \quad \mathrm{B},$$

where M is the ratio of the distances of two points measured in the direction of the axis to the distances of their images.

It is clear that the two laws A and B cannot hold at the same time unless $u = v$, and then $\mathrm{N} = \mathrm{M} = \frac{n}{n'}$ and the instrument has no considerable magnifying power (it becomes in fact a plane mirror when $n = n'$).*

Now a Microscope has very little "depth of focus," that is to say two points P and P′ are not in focus at the same time; but it does give, by means of wide-angled pencils, a clear image of the central portion of a small plane object when placed at a certain position and normal to the axis.

The law A must therefore be nearly true for a good Microscope.

Law B will then hold approximately for small values of $u$ and $v$ and yields the condition

$$M = N^2 . \frac{n'}{n} \quad . \quad . \quad . \quad . \quad . \quad . \quad C.$$

This being premised, the aperture of the instrument is effectively defined by Prof. Abbe, as the number of rays that it admits in a plane passing through the axis of the instrument from a plane standard object supposed in air. Further, the number of rays emanating from an object or converging to the image are counted by the angular breadth of the pencils of light emanating from, or converging to, each small element of the object or image multiplied by the linear dimensions of the object or image—it being supposed that the pencils have small angular breadth and are of the same intensity throughout.

In other words, *the aperture is proportioned to the square root of the quantity of light admitted by the objective under the given conditions.*

Apply this definition of aperture and the convention of counting rays to the telescope. If the method is a rational one it must yield the same result whether the rays are counted as they enter the objective or as they converge to the image.

In the case of the astronomical telescope we are dealing with objects subtending always a small angle at the instrument, of unknown absolute dimensions in many cases, and always so distant that the light proceeding from them is of equal intensity over an area indefinitely larger than that covered by any instrument.

The dimension of the object in this case must therefore be measured by the angle that it subtends at the observer's position.

Referring to law A, it can readily be shown that, if P Q is supposed to recede from the instrument while subtending a constant angle at some point near the instrument, the form that the equation ultimately takes is

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* *Note by Prof. Abbe:*—Mr. Hockin's new demonstration of the law of the sines is remarkable for its simplicity and generality; at the same time it includes a very simple and clever demonstration of a proposition, which I signalized in the article "Die Bedingungen des Aplanatismus," that a system of lenses which collects *wide*-angled pencils, *cannot* be aplanatic for a continuous row of foci along the axis, but can have only *isolated* pairs of conjugate *aplanatic* foci.

$$n \,.\, d \,.\, a = n' \,.\, p\,q \,.\, \sin v \quad . \quad . \quad . \quad . \quad \mathrm{A}';$$

or since, in the present case, $n = n'$,

$$d \,.\, a = p\,q \,.\, \sin v,$$

where $d$ is the distance of any ray incident parallel to the axis from that axis, and $a$ the angle that P Q subtends.

Fig. 2 represents this case.

Law A′ put in a geometrical form shows that the directions of any incident ray and the corresponding emergent ray cut on the surface of a circle centered at the image.

In practice the radius of the circle is so large in comparison with the diameter of the objective that $v$ is always a small angle and $v$, $\sin v$, and $\tan v$ for our present purpose may be treated as equal.

In the figure the equidistant parallel lines from $a$ to $b$ represent the direct incident pencil of uniform intensity, and the lines from $a'$ to $b'$ converging at C the corresponding emergent pencil. The directions of these rays meet within the objective on the circle $c\,d$ of large radius. The consecutive lines between $a'$ and $b'$ therefore make nearly the same angle with each other, and the light is nearly uniform in the pencil $a'$ C $b'$.

The direct pencil only is drawn, but as the object subtends always but a small angle at the instrument, the breadth of all incident pencils may be treated as equal, and the total number of rays incident on the objective is measured on the convention adopted by

$$d \,.\, a$$

where $d$ is the diameter of the objective.

Counting the rays emergent from the objective, they consist of pencils of angle $\frac{d}{f}$ and converge to a line of length $p\,q$; their number on the convention is therefore

$$p\,q \,.\, \frac{d}{f},$$

where $f$ is the focal length of the instrument; or, since

$$p\,q = f \,.\, a,$$

the number of the rays $= d \,.\, a$, the same expression as before, and $d$ represents the number of rays received from an object of unit angular dimensions and is the recognized measure of the aperture of the instrument.

Now apply the same method to the aperture of the Microscope. The instrument is suited for viewing at one time a small plane object, and a small plane disk must be taken as standard object. Again, this object may be in air or in some other medium, and a method of counting the rays must be adopted that will yield the same result whether they are counted in air or in any other medium through which they may pass. Let P Q be a section of a small body in a medium of refractive index $n$, $p\,q$ its image in a medium of index $n'$, A B a small portion of the surface bounding the media, and C the centre of curvature of the arc A B (fig. 3).

The rays coming from P Q are measured by a number proportional to

$$\mathrm{PQ} \times \angle^{\bullet}\mathrm{APB},$$

and equal, suppose, to

$$\mathrm{A} \times \mathrm{PQ} \times \angle^{\bullet}\mathrm{APB}.$$

The same rays reach $p\,q$, and in the medium $n'$ they are measured by $a \times pq \times \angle^{\bullet}\,\mathrm{A}p\mathrm{B}$, and these two expressions are to be the same.

$$\therefore \quad \frac{\mathrm{A}\,.\,\mathrm{PQ}\,.\,\angle^{\bullet}\mathrm{APB}}{\mathrm{A}\,.\,pq\,.\,\angle^{\bullet}\mathrm{A}p\mathrm{B}} = 1 \quad . \quad . \quad . \quad . \quad . \quad 1$$

but

$$\mathrm{PQ} = \mathrm{AP} \times \angle^{\bullet}\mathrm{PAQ} \quad . \quad . \quad . \quad . \quad . \quad 2$$

$$pq = \mathrm{A}p \times \angle^{\bullet}p\mathrm{A}q \quad . \quad . \quad . \quad . \quad . \quad 3$$

Suppose P A to make an angle $\theta$ with the normal A C, and $p$ A to make an angle $\theta'$ with the normal A C; then, as usual,

$$n \sin\theta = n' \sin\theta' \quad . \quad . \quad . \quad . \quad . \quad . \quad 4$$

Again, P A Q is a small increment of the angle $\theta$ and $p\,\mathrm{A}\,q$ is the corresponding increment of the angle $\theta'$.

$$\therefore \quad n \cos\theta\, \angle^{\bullet}\mathrm{PAQ} = n' \cos\theta'\, \angle^{\bullet}p\mathrm{A}q \quad . \quad . \quad . \quad 5$$

also

$$\mathrm{AP}\,.\,\angle^{\bullet}\mathrm{APB} = \mathrm{B}n = \mathrm{AB}\cos\theta \text{ ultimately} \quad . \quad . \quad 6$$

and

$$\mathrm{A}p\,.\,\angle^{\bullet}\mathrm{A}p\mathrm{B} = \mathrm{A}n' = \mathrm{AB}\cos\theta' \text{ ultimately} \quad . \quad . \quad 7$$

$$\therefore \quad \frac{\mathrm{A}}{\mathrm{B}} \cdot \frac{\mathrm{PQ}}{pq} \cdot \frac{\angle^{\bullet}\mathrm{APB}}{\angle^{\bullet}\mathrm{A}p\mathrm{B}} = \frac{\mathrm{A}}{\mathrm{B}} \cdot \frac{\mathrm{AP}\,.\,\angle^{\bullet}\mathrm{PAQ}}{\mathrm{A}p\,\angle^{\bullet}p\mathrm{A}q} \cdot \frac{\mathrm{AB}\cos\theta}{\mathrm{AP}} \cdot \frac{\mathrm{A}p}{\mathrm{AB}\cos\theta'}$$

$$= \frac{\mathrm{A}}{\mathrm{B}} \cdot \frac{\cos\theta\,\angle^{\bullet}\mathrm{PAQ}}{\cos\theta'\,\angle^{\bullet}p\mathrm{A}q}$$

$$= \frac{\mathrm{A}}{\mathrm{B}} \cdot \frac{n'}{n} = 1,$$

or we may put

$$\mathrm{A} = n$$

$$\mathrm{B} = n',$$

and the number of rays in any medium is counted by the length of the object × angular breadth of the small pencils coming from it × refractive index of the medium under the conditions implied in what goes before.

To return to the Microscope: Law A applied and interpreted geometrically shows that the direction of any incident ray cuts the directions of the emergent ray on the circumference of a small circle centered a little behind the object, but so near it, that for purposes of illustration it may be supposed to be centered at the object.* Fig. 4 represents this case.

P Q being a plane, the intensity of the light emergent from it at any angle varies as the cosine of the angle that the ray makes with the axis. If then the diameter A B is divided into equal parts, and lines through the subdivisions are drawn parallel to the axis cutting the circle in the points between $a$ and $b$, the unevenly distributed lines in the pencil $a\,P\,b$ represent the distribution of light in the incident pencil, and the nearly evenly distributed lines in the pencil $a'\,p\,b'$, the distribution of the light in the emergent pencil, which is seen to be nearly uniform.

The number of rays forming the half-image is therefore measured by $p\,q \times \angle^{\circ}\,a'\,p\,b'$

$$
\begin{aligned}
&= \tfrac{1}{2}\,\mathrm{N}\,.\,\mathrm{PQ}\,.\,\angle^{\circ}\,a'\,p\,b' \\
&= \tfrac{1}{2}\,2\,\mathrm{N}\,.\,\mathrm{PQ}\,.\,\sin\tfrac{1}{2}\,a'\,p\,b' \\
&= \mathrm{N}\,.\,\mathrm{PQ}\,.\,\frac{1}{\mathrm{N}}\cdot\frac{n}{n'}\,.\,\sin a\,\mathrm{P}\,p \\
&\qquad \text{or since } n' = 1 \\
&= n\,.\,\sin\tfrac{1}{2}\,a\,\mathrm{P}\,b \\
&= n \sin u \text{ in the notation of law A.}
\end{aligned}
$$

This is Prof. Abbe's formula for aperture, and the proof of it which has been given will not, I think, be found to differ essentially from Prof. Abbe's proof.

The only difference is that the form "ratio of clear opening to focal length is omitted." This definition seems, at first sight, somewhat arbitrary, but when we see that this expression, interpreted as it is in Prof. Abbe's demonstration, expresses the *square root of the light admitted from a standard object under fixed*

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* If $l$ is the distance between the object and the image, the centre of the circle is situated at a distance $= \dfrac{l}{\left(\mathrm{N}\frac{n'}{n}\right)^2 - 1}$ behind the image, and its diameter $= 2\,l \times \dfrac{\mathrm{N}\frac{n'}{n}}{\left(\mathrm{N}\frac{n'}{n}\right)^2 - 1}$.

*illumination*, it becomes evidently a rational expression for aperture.

Of course, in the comparison of lenses numerically, the square of $n \sin u$ must be used just as the square of the diameter of an object-glass is the true measure of its light-admitting power.

It remains to be shown that the convention adopted for counting rays is not merely one adopted because it yields consistent results geometrically, but that it is founded on physical facts. For this Prof. Abbe refers to Clausius. English readers will find Prof. Clausius' memoir on radiation in the last memoir of his work on Heat, edited by Hirst (J. Van Voorst, 1867). The nature of Prof. Clausius' argument may be illustrated thus.

Referring to the diagram fig. 3, let P Q be a section of a small circular disk radiating heat, $p\,q$ the section of another disk similar in all respects to the first and its "optical image." Suppose also that both are at the same temperature.

Let I be the intensity of normal radiation from P Q, and $i$ be the intensity of normal radiation from $p\,q$; then the quantity of heat sent from P Q to $p\,q$ in unit time is measured by

$$\mathrm{I}\,(\mathrm{PQ}\,.\,\angle^{\circ}\,\mathrm{APB})^2,$$

and that sent from $p\,q$ to P Q in the same unit time is

$$i\,(pq\,\angle^{\circ}\,\mathrm{A}p\mathrm{B})^2.$$

The ratio of these quantities is

$$\frac{\mathrm{I}}{i}\left(\frac{\mathrm{PQ}\,\angle^{\circ}\,\mathrm{APB}}{pq\,\angle^{\circ}\,\mathrm{A}p\mathrm{B}}\right)^2,$$

and this has been shown to be equal to $\frac{\mathrm{I}}{i} \cdot \frac{n'^2}{n^2}$.

Now unless $\frac{\mathrm{I}}{i} = \frac{n^2}{n'^2}$ this expression must differ from unity, and so a greater amount of heat would be sent from P Q to $p\,q$ than is sent from $p\,q$ to P Q, or *vice versâ*.

In either case one of the bodies would be heated at the expense of the other, and we should have in a short time a hot body heated by a cooler one without the intervention of any mechanism doing work. This would be contrary to the second law of thermodynamics, that heat cannot of itself pass from a colder to a hotter body, a law which is found to hold whenever tested by direct experiment, and one which has never led to false conclusions when used in predicting the phenomena that should result from given conditions, of whatever degree of complexity these may be.

Prof. Clausius treats of radiant heat as the means of transference of sensible heat from one body to the other, but the nature of the radiation is not of importance to the reasoning, and what is true of radiant heat is true of light in the case in question.

It follows that an object under given illumination will radiate more light when in a medium of refractive index $n$ than in one in a medium of lower refractive index $n'$ in the proportion of $n^2 : n'^2$.

This leads to the only point not considered in the preceding investigation.

The aperture was measured by the angular breadth of the pencils forming the image multiplied by the number of pencils.

The absolute intensity of the light in each pencil was not considered.

It is evident from equation A that if I is the intensity of normal radiation of the object, the light in a *small* central incident pencil of angular breadth $a$ is measured by a number proportional to $I\,a^2$ and this pencil has on emergence the smaller angular breadth $\frac{1}{N}\frac{n}{n'}\,a$, and the intensity of the light is proportional to $I\left(N\frac{n'}{n}\,a\right)^2$. But as I itself has been shown to vary as $n^2$ the intensity becomes proportional to $N^2 . a^2$ as $n' = 1$, or for a given magnifying power it is constant.

The result is that Prof. Abbe's formula squared does give the true aperture of the instrument measured by the amount of light used to form the image of a plane object under fixed illumination.

The same formula is also proportional to the resolving power of the lens, for consider a series of dark and transparent bands of small equal breadth $\frac{1}{2}\,l$, on a glass plane illuminated from below.

The light in any direction A P coming from A is reinforced by that coming from B when $AP - PB$ is equal to a whole number of wave-lengths (fig. 5). This is first the case when $AP - PB$ is one wave-length, say $\lambda$, or when $AB \sin u = \lambda = l \sin u$.

But $\lambda$ varies inversely as the refractive index of the medium and is equal to $\lambda' \frac{1}{n}$ say.

Then
$$\lambda' = l\,n \sin u \quad \text{or} \quad l = \frac{\lambda'}{n \sin u};$$

therefore the greater $n \sin u$ may be, the less may $l$ be, in order that the first pair of diffracted rays may enter the objective, and so form with the central pencil a pencil of finite angular breadth emergent from the objective and incident on the eye-piece, through the image of the object giving a defined representation of the object.

Hitherto plane objects only have been considered. When we deal with objects of other shape it is self-evident that angular aperture as such will have a marked influence on the appearance of the object, and whether that influence is useful or not, it must of course be taken into account in interpreting what is actually seen on viewing an object.

It would seem then that the "angular aperture" of an objective should be stated as well as the "numerical aperture." When it is known that a lens admits a pencil of such and such angular breadth from an object in a medium of given refractive index, the complete description of the lens is given in all qualities except magnifying power, though we still want the standard of comparison afforded by the numerical aperture notation. Take the case referred to by Prof. Abbe, say a cubical crystal of common salt. We do not see clearly at the same time the horizontal face of the crystal and its vertical sides, but by lowering the objective a narrow band on the four vertical sides is fairly focused, and by observing the apparent dimensions of this square band we are able to say that the crystal is a true rectangular parallelopiped at any rate. Moreover the clearness of the image of the band will depend evidently on the angular aperture of the lens.

Again, if oblique illumination is employed, what was at first symmetrical about the axis of the instrument is now symmetrical about an axis forming a definite angle with that axis, and so angular aperture will be important as such.

These considerations are perhaps too evident to require notice, but they appear to me to have some weight.

Lastly, it may be remarked that by law C the "depth of focus" in an immersion lens is greater than that of a dry air lens in the proportion of N : 1, by formula C.

## *Note by Prof. Abbe.*

On the preceding paper Prof. Abbe writes as follows:—

I agree that the measure of aperture is a photometrical one *in principle.* But by the expression, "number of rays" as opposed to "*mere* quantity of light," I desire to convey that the bearing of the notion is not *confined* to the photometrical functions of the lenses. The expression "quantity of light" would imply the *intensity* of the rays, which must be *excluded* in the estimation of aperture, because a greater intensity does *not* compensate for a smaller angle in regard to "aperture"; whilst it *does* so in regard to quantity of light, and a *purely* photometrical measure would have to be based on the estimation of the rays in the whole cone, not only in a plane section. In that respect the difference is, in fact, that the one is measured in one dimension, the other "in two dimensions," as is said by the author. The author makes the same difference: (1) by excluding the intensity of the rays, and (2) by introducing the square root of the photometrical equivalents of the angles as the measure of "aperture."

This being understood, I should agree that it is better to base the definition of numerical aperture upon photometrical principles directly, instead of on an indirect demonstration, by means of the ratio of linear aperture to focal length, which ratio should be considered as a secondary expression of aperture.

## IX.—*Note on the Proper Definition of the Amplifying Power of a Lens or Lens-system.*

### By Prof. E. Abbe, Hon. F.R.M.S.†

(*Read 12th March*, 1884.)

The generally adopted notion of "linear amplification at a certain distance" is in fact a very awkward and irrational way of defining the "amplifying power" of a lens or a lens-system. Unfortunately, there is little hope that a more rational expression will be generally adopted, because it will seem to be "too abstract," but it may, nevertheless, be useful to consider the following:—

In the formula $N = \frac{l}{f}$ the "amplification" of one and the same system varies with the length $l$, or the "distance of vision," and an arbitrary conventional value of $l$ (e. g. 10 in. or 250 mm.) must be introduced, in order to obtain comparable figures. The actual "linear amplification" of a system is, of course, different, in the case of a short-sighted eye, which projects the image at a distance of 100 mm., and a long-sighted one which projects it at 1000 mm. Nevertheless, the "*amplifying power*" of every system is always the same for both, because the short-sighted and the long-sighted observers obtain the *image of the same object under the same visual angle*, and consequently the same real diameter of the retinal image. That this is so will be seen from fig. 48, where the thick lines show the course of the rays for a short-sighted eye, and the thin lines for a long-sighted one, the eye in each case being supposed at the posterior principal focus of the system.

The semi-visual angle $u^*$ under which an object of semi-diameter $h$ is seen, is the *same* for both observers, as the change resulting from the different positions of the object concerns only the *degree of divergence* of the various pencils from the various points of the object (and the image), and does not alter the refraction of the principal (central) rays from the various points.

This consideration leads to an expression of the "power" which is in conformity to the last-mentioned salient fact. The quotient

$$\frac{\tan u^*}{h},$$

where $u^*$ is the semi-visual angle corresponding to $h$ the semi-diameter of the object, is a constant quantity for every system, not depending on the particular circumstances of the observing eye; and this quotient indicates, obviously, the greater or smaller visual angle, under which a given length $h$ is displayed by the system to *every* eye. The numerical value of this quotient gives the tangent of the visual angle, under which the *unit of length* ($h = 1$) is shown through the system. This quotient, therefore—i. e. the ratio of tan $u^*$ to $h$, or *the visual angle corresponding to the unit of length, measured by the tangent*—is the rational expression of the magnification or "*power*" of an optical system, because *every* observer will see every object enlarged through different systems in the exact proportion of the value of that quotient.

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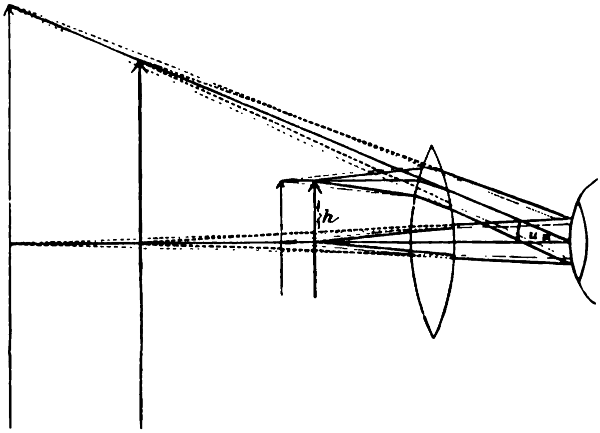
† The original paper is written by Prof. Abbe in English.

FIG. 48.



From the fundamental definition of the "equivalent focal-length" of a lens-system results the identity of the above-mentioned quotient with the reciprocal value of $f$ (focal length): we have

$$\frac{\tan u^*}{h} = \frac{1}{f}.$$

Consequently the reciprocal of the focal length of a system is, by itself, the proper expression of its amplifying power, because this reciprocal expresses numerically the visual angle (measured by the tangent) under which the unit of length appears through the system.

This very simple expression of the amplifying power of a lens-system is a strict one, it is true, under the supposition only which was mentioned above, that the place of the eye be at the posterior principal focus of the system, or, what is the same thing, that the *principal* rays from the various points of the object cross at that focus.

As far as the compound Microscope is in question, no other case needs to be considered. For the "eye-point" of the Microscope coincides, practically, with the posterior principal focus of the total system. With a hand-magnifier, however, the eye may change its place to some extent, and the crossing-point of the principal rays will therefore be subjected to deviations from the posterior focus of the system. In regard to this more general case the exact formula for determining the power of a system in the manner indicated above is

$$\frac{\tan u^*}{h} = \frac{1}{f}\left(1 + \frac{d}{l}\right) = \frac{1}{f} + \frac{1}{f} \cdot \frac{d}{l},$$

in which $l$ denotes once more the distance of distinct vision of the observing eye, and $d$ the deviation of the said crossing point, or the place of the eye, from the posterior focus. ($d$ must be introduced with positive sign if the focus is behind the eye, and with negative sign if it is in front.)

According to this general formula the exact ratio of the visual angle to the linear magnitude of the object is expressed by a principal term $\left(\frac{1}{f}\right)$, which is independent of all particular circumstances, and an additional term $\left(\frac{1}{f} \cdot \frac{d}{l}\right)$ which varies with the position and the accommodation of the observer's eye. As in all practical cases $\frac{d}{l}$ will be a small fraction, the additional term indicates merely a small correction, and this correction alone depends on the distance of vision and the place of the eye. The simple reciprocal of the focal length will therefore afford in *all* cases a proper measure of the amplifying power of a lens-system, because it expresses *that* component of the amplifying power which is inherent in the system itself, and independent of the variable circumstances under which it may be used.

The other generally adopted expression of the power by $N = \frac{l}{f}$ may be put on a *somewhat* more rational basis than is generally done, by defining the length $l$ (10 in.) not as "distance of distinct vision," but rather as "distance of projection of the image." As far as "distinct vision" is assumed for determining the amplification, the value of N has no real signification at all in regard to an observer who obtains distinct vision at 50 in. instead of 10 in., and in fact many microscopists declare the ordinary figures of amplification to be useless for them, because they cannot observe the image at the supposed distance. It appears as if—and many have this opinion—the performance of the Microscope in regard to magnification depended *essentially* on the accommodation of the observer's eye.

This misleading idea, resulting from the common expression, is eliminated by defining the 10 in. merely as the distance from the eye at which the image is measured—*whether it be a distinct or an indistinct image*. For if an observer, owing to the accommodation of his eye, obtains a distinct image at a distance of 10 feet, I may nevertheless assume a plane at a distance of 10 in. from the eye on which the distant image is virtually projected, and measure the diameter of that projection. Now this diameter is strictly the same as the diameter of that image, which another observer would really obtain with distinct vision at that same distance of 10 in. The only difference is, that in the former case we must take the centres of the circles of indistinctness instead of the sharp image-points in the latter case.

If the conventional length of $l = 10$ in. is *interpreted* in *this* way (as distance of projection, independently of distinct vision) the absurdity at least of a *real* influence of the accommodation on the power of a Microscope is avoided. It becomes obvious, that for long-sighted and for short-sighted eyes the same N must indicate the same visual angle of the enlarged objects, or the same magnitude of the retinal image, because it indicates the same diameter of the projection at 10 in. distance. (See fig. 48.)

## X.—*On Certain Filaments observed in Surirella bifrons.*

By John Badcock, F.R.M.S.

(*Read 9th April*, 1884.)

On the 5th April I collected some very fine diatoms from the noted Keston bog, among which examples of *Surirella bifrons* were very conspicuous, both by their abundance and size, and also by their very clean and active condition.

Selecting one for special attention, I noted that in its passage across the field it would occasionally *pass close to* certain small collections of vegetable débris (but without actual contact), when these small matters seemed to be caught by some projecting filament from the diatom, by which they were carried along with it for some distance. Then the diatom would free itself, but, coming in contact in the same manner with other similar material, the same thing would happen again.

Observing this very often with only a 2/3 in. objective, I tried a higher power. With the 1/4 in. I could not discover any more than before the cause of the phenomenon. At length, however, with a 1/2 in., which had been altered for use with the binocular arrangement, I discovered certain fine filmy processes projecting irregularly from the diatom, and which appeared to have caused this disturbance. Further and repeated observation confirmed my conviction of a correspondence between these projecting filaments and the disturbances noted, the significance of which could not be mistaken.

I now called my son, and asked him if he saw anything exceptional, and to sketch it for me. This he did, as shown in figs. 49 and 50. The filaments were seen repeatedly and very distinctly by both of us, whether the front or the side of the diatom was in view.

Fig. 49.

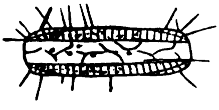
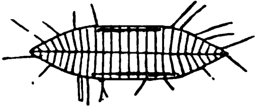


Fig. 50.



My attention was not confined to *one diatom* only. The appearance showed itself in many, but not in all, and there was a very perceptible difference in its development in different specimens.

I had been observing some *Arcellina* from the same gathering in which the *Surirella* were found, and was struck with the similarity between the filmy projections in *Arcella difflugia* with those of the diatom. Although those of the *Arcella* were much larger, yet the fine *non-granular* character was the same, as also their variableness and irregularity. They were simply as fine pencil shadings or smoke-like semi-transparent films, which in the *Arcella* were larger and of a more pronounced character than in *Surirella,* yet of the same amœboid nature in both.

As I was thus led—accidentally as it were—to compare these two forms of life, it seemed to me that the only *essential* difference between them was one of size. In this light one could hardly regard the diatom as of the vegetable kingdom pure and simple. However, my object is not to raise this vexed question of animal or vegetable nature, but simply to put on record my observation of these filmy protuberances as corroborative of previous observations made and recorded by other and more eminent workers in this department, but which of late years have been generally either ignored or considered as of no special significance.

I will only say that had I not seen a diatom before, or known anything of its classification, I should certainly have regarded this *Surirella* as a testaceous *Amœba.*

The special optical power and arrangement necessary to see this phenomenon in the diatom may be a subject of interest. I have only one objective with which I can see it distinctly (a 1/2 in.). It was strange and inexplicable to me that neither a higher nor lower power revealed it.

Now, whether there is any physiological problem involved, or any special relation between the structure of the eye and this particular optical power, may be a question worth further investigation by those competent to undertake it. I merely throw it out as a suggestion, which may or may not be worth anything. One thing is, however, desirable, and that is that such special aids should be sought as would enable any one readily to verify such observations for himself, for it seems certain that disputes arise and contradictions are made which a little more attention to this point would probably prevent.

# SUMMARY
OF CURRENT RESEARCHES RELATING TO
# ZOOLOGY AND BOTANY
*(principally Invertebrata and Cryptogamia),*
# MICROSCOPY, &c.,
INCLUDING ORIGINAL COMMUNICATIONS FROM FELLOWS AND OTHERS.*

## ZOOLOGY.

### A. GENERAL, including Embryology and Histology of the Vertebrata.

**Contributions to the History of the Constitution of the Ovum.**†——In this report C. Van Bambeke discusses the relations of the germinal vesicle to the periphery of the yolk. He finds that under the influence of certain reagents, the young ovarian eggs of bony fishes (*Leuciscus*, *Lota*) exhibit the presence of a membranous pouch, which incloses the germinal vesicle, and is attached to the periphery of the yolk. In *Leuciscus* the peripheral portion has the form of a nucleiform body (vitelline nucleus?), the long axis of which lies parallel to the surface of the egg. The apparent striation between this nucleiform body and the germinal vesicle is due to the folds of membrane; and it is probable that the arrangement described and figured by Schäfer as obtaining in the ovarian egg of the rabbit is of the same character. The pouch in question may be considered as a limiting layer, or condensation of the cellular reticulum, which, in the normal state, separates the internal from the external vitellus, to use the nomenclature of Pflüger; the nucleiform body will then correspond to the internal yolk. This disposition of parts has perhaps some relation to the maturation and fecundation of the egg, inasmuch as it may be the passage by which the directive corpuscles escape to the exterior, and the fecundating spermatozoon enters to unite with the female pronucleus. Further researches are necessary to decide whether there is any relation between the division of the yolk into two zones, and the mode in which the yolk-elements are deposited within the egg. The union of the nucleus with the periphery of the cell, which has been observed by Leydig in various animal cells, and by Schäfer in the young ovarian ova of the fowl, seems to be a different phenomenon; for there is not then any limiting layer, nor any folds of membrane, but rather a condensation of the cellular reticulum.

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* The Society are not to be considered responsible for the views of the authors of the papers referred to, nor for the manner in which those views may be expressed, the main object of this part of the Journal being to present a summary of the papers *as actually published*, so as to provide the Fellows with a guide to the additions made from time to time to the Library. Objections and corrections should therefore, for the most part, be addressed to the authors. (The Society are not intended to be denoted by the editorial "we.")

† Bull. Acad. R. Belg., vi. (1883) pp. 843–77 (1 pl.).

The author is unable at present to say certainly what bearing his observations have on those lately made by Balbiani, Fol, and others, which have only come to his knowledge since his paper was completed.

**Origin of Metameric Segmentation.***—In this suggestive essay A. Sedgwick discusses the origin of the metameric segmentation and some other morphological problems. To the hypotheses which he has already suggested—that the mouth and anus in most of the higher groups have been derived from some such elongated opening as is now seen in the Actinozoa, that the somites of segmented animals are derived from a series of pouches of the archenteron comparable to the pouches now found in Actinozoid polyps and Medusæ, and that the nephridia are derived from specialized parts of these pouches—he now adds a fourth, that the tracheæ are not developed from cutaneous glands of a worm-like animal, but are rather to be traced back to simple ectodermal pits, represented to-day by the subgenital pits of the Scypho-medusæ, by the pits into the cephalic ganglia of Arthropod embryos, and by the canal of the central nervous system of the Vertebrata.

It is pointed out that the essence of all these propositions lies in the fact that the segmented animals are traced back not to a triploblastic unsegmented ancestor, but to a two-layered Cœlenterate-like animal with a pouched gut, the pouching having arisen as a result of the necessity for an increase in the extent of the vegetative surfaces in a rapidly enlarging animal. In framing these hypotheses, support is found in facts of exactly the same nature as those which have been used in tracing the evolution of the nervous and muscular tissues.

The difficult problem of the homology of the mouth and anus with the mouth of the Cœlenterata is first attacked; their mode of development is shown to be coincident, and their relations to the archenteron and the neural surface of the body to be similar. The fact that in various higher forms the blastopore gives rise in some to the mouth and in others to the anus is to be explained by the supposition that the blastopore primitively gave rise to both mouth and anus, and that its specialization as a larval organ has caused the variability of its subsequent history. This doctrine is supported by the characters of the mouth of the existing Actinozoa where the two ends are open and the middle closed, and by the fact that in the primitive *Peripatus* the elongated blastopore does give rise to both mouth and anus. If this be true, it follows that Balfour was right in thinking that the stomodæum and proctodæum are not in all cases completely homologous.

The common ancestor of the Triploblastica and Actinozoa may be supposed to have been a diploblastic bilateral form with an enlarged oral surface, and an elongated mouth which, by the adhesion of its middle portion, was functionally divided into two openings; the nervous system was distributed in the ectoderm over the whole body, but was probably especially concentrated on the oral surface.

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* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 43-82 (2 pls.).

The view that an enterocœle was derived from one pair of archenteric pouches has been given up since Hatschek discovered that, in *Amphioxus*, a series of diverticula are formed; the similarity between the embryo of *Amphioxus* and an Actinozoon polyp suggests that the mesoblastic somites of segmented animals are derived from a diploblastic cœlenterate-like ancestor with folded gut-walls, and the Cœlenterata differ only from segmented animals in that the alimentary or archenteric pouches (mesoblastic somites) and the alimentary canal do not become separate. Connected with this absence of a distinct cœlom is the low state of differentiation of such cœlomic structures as the excretory organs, and the absence of a separate vascular system.

Sedgwick is of opinion that the excretory organs were not at first used for the excretion of nitrogenous waste products, but for the riddance of the undigested and solid excretory products, and that this process was at first intracellular. Pores are certainly found in the Diploblastica; the circular canal of the Medusæ may be easily conceived as becoming the vertebrate segmental ducts, and a temporary longitudinal canal has been observed by Hatschek in *Polygordius*. The gill-slits are regarded as being serially homologous with nephridia.

The author concludes the first half of his paper by pointing out that his object has been to show that the majority of the Triploblastica are built upon a common plan; that that plan is revealed by a careful examination of the anatomy of Cœlenterata; that all the most important systems of organs of those Triploblastica are found in a rudimentary condition in the Cœlenterata, and that all the Triploblastica referred to (Annelida, Arthropoda, Mollusca, Vertebrata, *Balanoglossus*, *Sagitta*, and the Brachiopoda), must be traced back to a diploblastic ancestor common to them and the Cœlenterata.

In the second part Sedgwick applies his hypothesis to the just mentioned groups; from the ideal ancestor, a little more advanced than the common Cœlenterate ancestor, two stocks branched off. In one, the Invertebrata, the mouth and anus (which soon became separated) remained on the neural surface, and a præoral abneural lobe was developed which, being carried first in movement became specially sensitive. In the other stock the mouth and anus became terminal and a projection on the neural surface of the body overhung the mouth; this is the stock of the Vertebrata and of *Balanoglossus*. The further changes in the two stocks are next discussed, but space will not permit of our following the author.

In conclusion there are some observations on the structures known as primitive streaks; these are always connected with the formation of the mesoblast, are not found in free larvæ, are always median and unpaired, are always caused by rapid proliferation of cells, and vary in position in different animals. The differences which obtain are at present very difficult of explanation, but one is perhaps to be found in the supposition that owing to the early specialization of the enteron the mesoblast has to be formed in some other than the primitive mode, and the proliferating cells of the streak do nothing else than divide and give origin to the mesoblastic bands.

In the newt the blastopore appears to persist as the anus, but examination of sections is still necessary to make this point certain.

**Gastræa Theory.***—O. Bütschli criticizes the theories of Häckel, Lankester, and Metschnikoff, and puts forward some new views concerning the origin of the Metazoa.

The primitive form of the Metazoon is, according to this view, a two-layered disk, which may be termed a *placula*, and which is supposed to have originated from some such form as *Gonium*, a genus of Volvocineæ, consisting of a flat disk made up of many cells arranged in one layer. It may readily be imagined that this one-layered cell-aggregate soon undergoes differentiation, one side serving especially for locomotion, and the other for nutrition; and that these functions become localized one in each layer of the placula. Some difficulties arise about the way in which the gastrula takes its origin from this two-layered placula, but the clue is to be found in the development of certain nematodes: in *Cucullanus* and *Rhabdonema* the result of the egg-cleavage is the formation of a two-layered embryo exactly similar to the hypothetical placula; in many other animals, e. g. *Lumbricus*, which undergoes a developmental stage similar to that just described, a segmental cavity is formed between the two layers and the embryo becomes a blastula; in other animals the segmentation cavity is more highly developed and we get a typical blastula; these facts indicate that the blastula is not so ancient a developmental stage as the flat two-layered embryo of the Nematodes.

This two-layered placula reaches the gastrula form by a growing together of the two ends, and the reason for this process of growth is the hollowing out of the endoderm layer to form a receptacle for food, which would evidently be of advantage to the animal; also the approximation of the endoderm cells would also enable the animal to seize larger masses of food. This theory, therefore, renders intelligible the origin of the gastrula form, which the previous theories do not.

The marine organism *Trichoplax adhærens* recently described by F. E. Schultze, is a placula, and its discovery, Bütschli considers, lends great support to the theory advocated in his paper.

**Changes of the Generative Products before Cleavage.**†—M. Nussbaum describes his account of the changes undergone by the generative products prior to the cleavage of the ovum as an essay on heredity. He commences with an account of the copulation and development of the genital products of *Ascaris megalocephala*. Attention is directed to the absolute similarity between the early stages of either sex, and it is pointed out that both the primitive ova and the spermatogonia increase by indirect division of the nucleus; all stages of this process may be observed. Later on, changes are to be observed in both the nucleus and the cell-body; granules deposited in the protoplasm constantly increase in size, and the spermatocytes seem to be undergoing division; the later stages of the development of the spermatozoon are marked by the increase in number and fusion of the large refractive bodies, which, at first small and hard to count, end by forming a highly refractive body. As is well known, the spermatozoa of the Nematoids are not provided with a single tail; there are rather long, pseudopodioid tentacles, which are, at the body temperature of the host, actively mobile, and which consist of a hyaline ground-substance with finely granular deposits.

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* Morph. Jahrbuch, ix. (1884) pp. 415-27.

† Arch. f. Mikr. Anat., xxiii. (1883) pp. 155-213 (3 pls.).

The only point of resemblance in the modes of development of the ova and spermatozoa (after, of course, the very earliest stages) lies in the fact that both kinds of genital products are disposed radially around a central rachis. The germinal vesicle becomes irregular in form, as the ovarian tube increases in thickness; the germinal spots become grouped into two or three grains, which, later on, undergo various changes, whether the egg is fertilized or not. If the ova are treated with acetic acid or with a mixture of alcohol and ether, so as to extract the contained spheres and crystals, a trabecular structure is to be detected; this is of some importance, as it explains the decrease in the size of the yolk after fertilization.

As a result of a large number of observations, Nussbaum states that only one spermatozoon enters each ovum; the egg becomes smooth in contour, but at the point where the spermatozoon had entered the ovum is a little swollen; the changes undergone by the male element are fully described.

As soon as the ovarian and spermatic nuclei have united, cleavage commences. The colourable substance of the nucleus becomes arranged in filaments which gradually thicken and diminish in number. The ordinary spindle-shaped figure appears, and four chief filaments are to be made out. At the poles of the spindles there is a distinct radiation in the protoplasm. In these animals a large number of ova are never fertilized.

The theory of fertilization is next considered under the several heads of the entrance of the spermatozoa and their changes within the egg, the formation of the polar globules, and the appearance of the two nuclei in the fertilized ovum. The conclusion is arrived at that the act of fertilization in the simplest and in the most complicated organisms consists in the union of the identical parts of two homologous cells.

The inheritance of individual or transmitted peculiarities is regarded as being due to the influences exerted on the generative cells of the individual, for they are subjected to conditions which had a modifying influence on the ancestral organism.

The author finally discusses the part played by the different portions of the seminal cell, and comes to the following conclusions:—

The nucleus of every seminal cell is thickened, and is in all cases retained by the mature seminal body; in spermatic filaments it forms the head. During impregnation of the ovum, the modified nucleus fuses with the ovarian nucleus. The protoplasm of the seminal cell forms the covering of the "head," the median portion, and, where such are present, the processes of the spermatozoon; it either remains capable of amœboid movement or unites with the nucleus to form a ciliated cell. In many cases the rudiment of the investment of the "head" or of the median portion may be recognized as a secondary nucleus or a thickening in the protoplasm of the spermatocyte. This investment of the head does not play any essential part in fertilization, and is, indeed, ordinarily got rid of before the spermatozoon passes into the egg; when it does pass into the egg it becomes mixed up with the yolk like the other parts of the seminal body that are derived from the protoplasm of the spermatocyte.

**Development of Spermatozoa.***—A. Swaen and H. Masquelin contribute a short abstract of results derived from a study of the development of spermatozoa; the types investigated were certain Selachians, the salamander, and the bull. The epithelium of the testicles of these animals is formed by two distinct types of cells, (1) "male ovules," (2) cells of the follicles; the former give rise to the spermatozoa in the following way: each of the cells divides and forms a number of small cells—the spermatocytes, which always remain united by a portion of the protoplasm of the mother-cell which persists as intercellular substance; the whole group of spermatocytes may be termed a spermatogemma; the spermatocytes are gradually metamorphosed into spermatozoa, being termed in the intermediate stages nematoblasts, the spermatogemma becoming therefore a nematogemma. During the course of development the spermatocytes and especially the nematoblasts are grouped in different ways, varying in the different types of animals studied, but finally unite into bundles of spermatozoa, in which all the elements are arranged parallel to each other.

The follicular cells form an envelope, which may be more or less complete and last for a longer or shorter time, to the male ovules and the spermatogemmæ; later they become fused with the intercellular substance of the nematogemma, and are no doubt actively concerned in the varied grouping of the nematoblasts, and also in the expulsion of the completely developed spermatozoa. Comparing the development of the spermatozoa and ova, the following similarities and differences may be noted; in both there is an ovule surrounded by a more or less complete layer of follicular cells; in the ovary this cell developes at once into the ovum, and the follicular cells multiply actively; in the testicle the ovule developes by indirect division, while the follicular cells hardly multiply at all, and more often increase in size.

The paper concludes with a more detailed description of the process of development in the several types.

**Human Embryo.**†—H. Fol makes an important contribution to our knowledge of the structure of the human embryo, obtained from the study of an embryo 5–6 mm. in length and probably about three weeks old; his results gain additional interest from the fact that no embryo of this age has ever been before examined.

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* Bull. Acad. R. Belg., vii. (1884) pp. 42–51.

† Arch. Sci. Phys. et Nat., xi. (1884) pp. 93–5.

The branchial clefts, three in number, were of a very complex form; the second, lying between the hyoidean and first branchial arch, was entirely open; the third descends in the form of a pouch on the sides of the tracheal artery; the origin of the thyroid gland is in front of the base of the tongue; the pancreas is represented by a short cœcum directed dorsally; the presence of a commencing rudiment of this organ is interesting from the fact that it has not been discovered yet in larger embryos as long as 7 mm.; the ureters open on the ventral side of the cloaca, and not dorsally as has been erroneously stated; two pairs of branchial arteries are present, the hyoidean and the first branchial, as well as an unpaired artery, up to the present unrecorded, which is given off from the aorta and accompanies the vitello-intestinal vessel; the heart as yet only shows two cavities; the posterior extremity of the body presents the appearance of a long tail, but it has no supernumerary vertebræ, in fact, not the full number, since the entire vertebral column only consists of thirty-three vertebræ.

**Placentoid Organ in the Embryo of Birds.***—M. Duval directs attention to the sac which, in a chick, may be seen to be appended to the lower end of the umbilical vesicle. Sections of smaller ova show that both the outer and inner surfaces are formed by the chorion, and that the inner surface developes villous processes which are plunged into and absorb the mass of albumen; they are supplied with vessels from the allantois. Such an organ may, the author thinks, be well called a placentoid sac. After having played its part as an organ for the absorption of albumen, it undergoes atrophy. Duval thinks that the discovery of this sac shows new points of affinity between placental and aplacental forms, and that its special structure in the bird is due to the presence of a shell which forces the villi to be developed on the inner instead of on the outer surface of the chorion. While the inner surface has a nutrient the outer has a respiratory function, and therefore the sac is in all respects comparable to the placenta of the Mammalia.

**Development of the Spinal Nerves of Tritons.**†—M. Redot finds that, in Tritons, the spinal ganglion and the dorsal root of the nerve are formed by a prolongation of cells which arises from the upper part of the medullary tube and is never separated from it. The ventral root is developed later, and at the expense of the medullary tube; it is (from at first?) fibrillar in structure, and only becomes secondarily united with the spinal nerve. The author remarks that, although his conclusions differ from those of some very distinguished observers, he does not despair of finding them confirmed.

**Poison of Batrachians.**‡—G. Calmels finds in the poison of the toad a small quantity of methylcarbylamine, and describes the method by which it may be formed synthetically. In the newt the corresponding acid is contained in globules which have the microscopic appearance of milk-globules, but differ from them chemically by being soluble in water. The physiological properties of the poison of the salamander are the same as those of that of the scorpion, and resemble those which have been observed with amylcarbylamine. The author has not yet studied the poison of serpents, but he thinks that they have probably the same kind of constitution. The general biochemical mode of formation may be thus defined. Every amide-compound, whether simple or a peptone, may fix the elements of formic acid in the nascent state, and give rise to a carbyl-compound of toxic properties and unstable in composition. Every methyl group which is insufficiently destroyed by oxidation gives rise not to carbonic but to formic acid, and so furnishes the elements of the carbyl-compound.

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* Comptes Rendus, xcviii. (1884) pp. 447–9.

† Arch. Sci. Phys. et Nat., xi. (1884) pp. 117–46 (1 pl.).

‡ Comptes Rendus, xcviii. (1884) pp. 536–9.

**Development of Lacerta agilis.***—H. Strahl gives a further account of the developmental process at the anterior end of the embryo of *Lacerta*. In a previous communication by the same author it had been pointed out that the head of the embryo consists up to a comparatively late period of ectoderm and endoderm only, the mesoderm being entirely absent.

Some of the more important results of the present communication are as follows:—The vascular area which is at first only developed at the sides of and behind the embryo grows forward and unites above the head to form a single oval disk; before this has taken place the cleavage of the mesoderm is visible in the anterior margins of the vascular area, and the fusion of the two cavities thus formed leads to the uniting together of the two sides of the vascular area. The larger anterior portion of the amnion is formed by growth from before backwards without any lateral folding of its ectodermic layer. The formation of the false amnion is very different from its formation in the chick; in the latter the folds of the splanchnic layer of the mesoderm and of the endoderm appear *before* the complete closure of the amnion, while in the embryo of *Lacerta*, these same folds which inclose the embryo, and may therefore be termed the false amnion, appear *after* the closure of the amnion. Another difference between the embryo chick and the embryo lizard is to be found in the relation between the closure of the body-cavity and the closure of the head intestine; in *Lacerta* the body-cavity closes almost immediately after the closure of the intestine, while in the chick the ventral sides of the body-cavity remain separate from each other long after the closure of the intestine. The twisting of the embryo on to the left side causes a like twisting of the anterior portion of the amnion, which is by this time entirely closed; at the posterior end of the embryo, where the two folds of the amnion have not yet become united, this twisting of the amnion does not take place, inasmuch as the left fold grows more rapidly than the right, and so the two, when they come to unite, remain in the same place as the egg membrane, and do not participate in the twisting of the embryo.

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* Arch. f. Anat. u. Physiol. (Anat. Abtheil.), 1884, pp. 41–88 (2 pls.).

**Development of Teleostei.***—C. Kuppfer continues his studies on the development of the Vertebrata, and treats of the Teleostei. Two varieties of trout were selected for study. The blastoderm on the eighth day presented a round area with a prominent knob at the posterior extremity (*Schwanzknospe*); in front of this lies the embryonic shield. The next step is an invagination upon the surface of the latter, exactly as in birds and reptiles, forming a longitudinal furrow which subsequently is crossed at right angles by another furrow; this transverse furrow is only a temporary structure, and presently vanishes, leaving only the longitudinal furrow; at the hinder end of the primitive streak, its margins unite to form a median axial band, which extends as far as the caudal knob. By the beginning of the twelfth day the primitive streak had disappeared, and the axial band a little wider at its anterior extremity occupied the middle line of the embryonic shield coinciding exactly with the anterior extremity of the primitive streak. The disappearance of the primitive streak coincides in point of time with the enclosure of half the yolk within the blastoderm; when the cells of the blastoderm pass beyond the equator of the egg, the primitive streak is entirely replaced by the axial band.

At the time of the appearance of the head, the axial band becomes slightly coiled; the " head " consists of the rudiment of the brain and eyes, and one pair of visceral arches; it is developed independently of the primitive streak; though the brain is continuous with the axial band, it is marked off from it by a constriction. The provertebræ which next appear are formed from the axial band, and the anterior ones are developed before the posterior ones; in many other Teleostei the first pair of protovertebræ are situated more in the middle and the process of growth extends forwards as well as backwards. No other pairs of visceral arches are developed in the neighbourhood of the first. The earliest rudiment of the spinal cord appears as a new formation upon the axial band, and is continuous with the brain; the central cavity of both, which is a secondary formation, commences in the eyes and passes down the brain into the spinal cord; this central cavity shows widenings here and there in the brain which do not correspond to the subsequently formed ventricles.

**Influence of High Pressures on Living Organisms.**†—P. Regnard has been able to make some experiments with a press giving a pressure of 1000 atmospheres; he finds that under such pressures as obtain on the bed of the ocean, plants, infusoria, molluscs, annelids, and crustacea fall into a somnolent condition, or one of " latent life "; fishes, when exposed to similar pressures, die. Experiments made show that muscles of the frog increase in weight after being subjected to a pressure of 400 atmospheres, but it is not yet known whether this change is chemical or physical.

Interesting points of resemblance are to be detected between these results and those obtained by the 'Talisman' deep-sea explorations;

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* Arch. f. Anat. u. Physiol. (Anat. Abtheil.), 1884, pp. 1–40 (2 pls.).

† Comptes Rendus, xcviii. (1884) pp. 745–7.

Milne-Edwards has remarked that below 2000 metres the fauna changes. Observations should now be made on the characters of the animals that are brought up dead from great depths; the causes ought to be comparable, though of course of a converse nature, to those that operate on animals subjected to artificial compression.

## B. INVERTEBRATA.

**Intracellular Digestion of Invertebrates.***—E. Metschnikoff insists on the necessity of collecting physiological as well as morphological evidence before discussing the evolution of any system of organs. The author offers some answers to the question whether the lowest Metazoa have not retained the power of using any or all the cells of their body for the purpose of ingesting food, and commences with ingestion by ectodermal cells.

Sponges, unfortunately, are not well suited for observations on the activities of ectodermal cells, and as yet there is no very definite evidence in favour of intracellular digestion by the ectodermal cells of those Metazoa. If powdered carmine be suspended in the water surrounding a *Plumularia*, a considerable quantity will soon enter the substance of the ectoderm by the nectocalyces, which send out various kinds of pseudopodia; in some cases these may be seen eating up, by means of their ectoderm, the dying hydranths of a colony of *Plumularia*; the food thus taken in remains in the ectoderm and is not passed on into the endoderm. *Actiniæ* also exhibit ectodermal digestion, and gastrulæ have sometimes been observed which are asymmetrical in form and dirty in appearance, owing to the ingestion by their outer cells of a large quantity of foreign matter; the number of particles in the ectoderm diminishes as the gastric pouches become developed. Ectodermal nourishment may also be observed in the ovarian ova of animals whose generative cells are ectodermal, such as *Tubularia* and *Hydra*.

Wandering mesoderm cells perform intracellular ingestion and digestion not only in sponges, but in the larval forms of certain Echinoderms, where they digest the cellular débris of the disappearing organs, and phenomena of this kind are so constant among Echinoderms that they may be regarded as normal and necessary events in the life of their larvæ, where they play the same part as the osteoclasts of vertebrate bone. The author thinks that the same resorbent function is to be noticed in the larvæ of Ascidians, and may perhaps be found in Arthropods.

Metschnikoff has extended to *Aurelia aurita*, Schneider's observation of the resorption of generative products by amœboid cells in the Hirudinea. In attempting to define the extent of this property of intracellular digestion, the author has studied the transparent and hardy *Bipinnaria asterigera*, and *Phyllirhoe bucephalum*; giant cells appeared round foreign bodies injected beneath the epidermis, whether they were merely particles of carmine or a drop of human blood. In other words, in most though not in all cases we find that when mesoderm cells are confronted with a large mass of food-material which they cannot devour singly, they fuse into a plasmodium, which eats up the whole available food. Not only blood but milk also is absorbed by mesodermal cells, and further these cells appear to have some means of distinguishing between desirable and undesirable substances. The property of ingestion is not confined to the lower forms, for Koch has observed both *Bacillus anthracis* and the bacillus of septicæmia inclosed in white blood-corpuscles; the power of intracellular ingestion is, in other terms, used as a protection against harmful bodies which come to an organism from without. Septic organisms, then, must be a very old source of trouble, and some arrangements, such as the peculiar test of Ascidians or the nematocalyces of *Plumularia*, may owe their origin to their influence.

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* Arbeit. Zool.-Zoot. Inst. Würzburg, v. (1883) pp. 141–69 (2 pls.).

Metschnikoff hopes that the advances lately made by pathology will benefit zoology, which, in its turn, will help to form a comparative pathology based on the doctrine of evolution.

In a further communication[*] E. Metschnikoff discusses the ancestral history of the inflammatory process. He has lately applied the name of phagocytes to certain cells which have the power of ingesting and sometimes of absorbing food-particles; the intracellular absorption which goes on in the mesoderm of the Invertebrata, is found to obtain also in that of the Vertebrata. The tail of the Batrachia, during the early stages of its absorption, contains a number of cells, which, when left undisturbed, throw out fine radiating pseudopodia; these contained remnants of nerve-fibres and muscle-cells: phagocytes, then, play as important a part in the metamorphosis of Batrachians as of Echinoderms; and pathologists have afforded evidence of their agency in the so-called active degeneration of muscles and nerves.

A frog fed with bacteria was soon found to have them especially abundant in the phagocytes of the spleen, which, therefore, is probably a prophylactic organ, analogous in function to the nematocalyces of *Plumularia*. The author has tested in a *Triton* the theory he holds as to the phenomena of inflammation in invertebrates being primitively nothing more than a collection of phagocytes assembled to devour the exciting object; he touched a point of the tail of a *Triton* with a small piece of nitrate of silver, and then washed it with salt solution. Branched connective-tissue-cells collect round the inflamed spot, and eat up blood-corpuscles, carmine granules, and particles of pigment. In the frog there is evidently an active wandering of the white blood-corpuscles. When a fully gorged phagocyte dies, it is immediately devoured by another. Inflammation then is not, as is ordinarily supposed, due primarily to a morbid condition of the walls of the blood-vessels; it is a struggle between phagocyte and septic material, and it is in vertebrates alone that the vascular system, owing to the insufficient number of extra-vascular phagocytes, takes part in the struggle. The active passage of the white and the passive exit of the red blood-corpuscles is rendered possible by the changes in the cells of the walls of the capillaries due to the irritation set up by the poison.

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[*] Quart. Journ. Micr. Sci., xxiv. (1884) pp. 112-7.

## Mollusca.

**Gustatory Bulbs of Molluscs.***—W. Flemming discusses the nature of the organs found on the tentacles of various molluscs which have the structure of gustatory bulbs. On the tentacles and marginal tactile organs of *Trochus cinerarius* the author has observed closely packed long papillæ, which are also scattered over the edge of the mantle and the head. In a fresh papilla there is an indistinct internal longitudinal striation which, on isolation, is seen to correspond to a central bundle of long cells; these cells are provided with fine short cilia, of which there are several on each cell; by far the largest part of the papilla is composed of epithelial cells. Gold-staining reveals the presence of primary nerves giving off a large number of lateral branches, sufficient apparently to supply each papilla with a terminal nerve. Structures of a similar character are to be found among the Lamellibranchiata.

The organs just described may, it is clear, be fairly compared with those which F. E. Schulze has spoken of as the gustatory organs of tadpoles, which are, likewise, freely projecting epithelial papillæ; nor do these, except in their position, differ essentially from the gustatory bulbs of mammals; the only important difference between the organs of the Mollusca and the Vertebrata is to be found in the fact that in the former the end-hairs of the central sensory cells project freely, while in the latter they still lie within the bulb; as, however, the ends of the hairs are, even in the latter case, in direct contact with the surrounding fluid, the difference is not one of much importance.

Although it is not certain that the end-organs described as existing in certain Mollusca have a gustatory function, yet Haller's suggestion to this effect has much to recommend it. From the point of view of developmental doctrines it is certainly of interest to observe that in some forms there are specific sensory organs at the very points where in most, and even in the most closely allied forms, there are only scattered ciliated cells. It is for the zoologist to extend the area of these observations.

**Morphology of the Renal Organs and Cœlom of Cephalopoda.**† —C. Grobben first deals with *Sepia officinalis*, then with *Eledone moschata*, and next treats of *Nautilus* in a comparative way. As is well known, the last-named cephalopod has four instead of two renal sacs, but it is not yet certain whether this arrangement is the more primitive or not. Those who regard *Nautilus* as phylogenetically the more ancient form would be naturally inclined towards the former view; against this, however, there are certain facts to which Ihering has already directed attention. That anatomist has pointed out that the anterior renal sac has no connection with the cœlom, and that, therefore, it is a structure which has not been reduced in the other or dibranchiate Cephalopoda; Grobben now suggests that it is an offshoot of the primitively simple, and in *Nautilus* posteriorly placed, kidney;

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* Arch. f. Mikr. Anat., xxiii. (1884) pp. 141–7 (1 pl.).

† Arbeit. Zool. Inst. Wien, v. (1883) pp. 179–252 (3 pls.).

an explanation for its presence is to be found in the supposition that the renal sac underwent division in consequence of the development of the new gill and the correlated appearance of a second branchial artery.

If Grobben's view of the origin of the double kidney be correct, it follows that the two kidneys on either side of the body of *Nautilus* correspond to the single kidney of the Dibranchiata. The great cavity which contains the heart, stomach, and genital gland is, as Vigelius has already shown, the homologue of the secondary cœlom of the rest of the Cephalopoda; and it is a matter of fact that the development of this cavity is similar in *Sepia* and in *Nautilus*. The author agrees with Lankester and Bourne in regarding the pyriform appendage of Owen as the rudimentary genital duct of the left side.

The secondary cœlom of the other Mollusca is next discussed. It is shown that in *Sepia* this cavity is a large space which communicates with the kidneys by the two ciliated funnels, that it is lined by epithelium and contains in its anterior part the heart with its afferent and efferent vessels, the branchial hearts, and the pericardial gland; and in its hinder part the genital gland and the stomach. Between the two halves there is an incomplete septum. If we carefully bear in mind these relations, it is not difficult to discover the secondary cœlom of other molluscs. It may be seen both in Gastropods and Lamellibranchs, where the epithelial investment of the pericardium has already been detected by various observers. In the former (e. g. *Helix*) it contains the heart and its auricle, in the latter (e. g. Naiades) the heart and auricles and part of the intestine. This pericardium, however, is not the sole homologue of the secondary cœlom, the cavity of the genital gland must be also regarded as being originally a portion of it, just as it is permanently in *Sepia*.

Another organ which, in the Lamellibranchs, also belongs to the cœlom is the reddish-brown organ of Keber, which is made up of cæca lined by an epithelium which is a direct continuation of that of the pericardium. It may be regarded therefore as the homologue of the pericardial gland of the Cephalopoda and have the same name applied to it. It has probably an excretory function.

In the Solenogastres, as Hubrecht has already pointed out, the body-cavity is much reduced; the only modification to be made in his account is to include the cavity of the genital gland as part of secondary cœlom. In Chitons the space is larger and incloses part of the digestive tract.

After a summary of the views of preceding naturalists on the affinities of the Cephalopoda, Grobben states and expounds the view that *Dentalium* is the remnant of a primitive form from which the Cephalopoda took their origin. *Dentalium* resembles them in its only slightly disturbed bilateral symmetry, its elevated visceral sac, and in the development of the pallial cavity behind that sac; it differs especially in having the mantle cavity open above. Other resemblances are pointed out in detail. The characters of *Dentalium* justify the establishment of a separate group of Solenoconcha.

Grobben does not agree with those who regard the Pteropoda as close allies of the Cephalopoda; he looks upon them rather as closer to the Gastropoda, and thinks that the most primitive Pteropods are those that are asymmetrical externally, the bilateral symmetry of a number of forms being due to their pelagic mode of life; other resemblances to the Cephalopoda are of an atavistic nature.

In conclusion, the question whether the Mollusca are "Pseudocœlia" or "Enterocœlia" is answered in favour of the latter view.

**Procalistes: a young Cephalopod with Pedunculate Eyes.***—*Procalistes Suhmii*, which Prof. E. Ray Lankester describes and figures, is a young cephalopod with pedunculate eyes, whose general aspect closely resembles a clionid pteropod, for which, indeed, the late R. von Suhm, in his preliminary investigation of a living specimen, mistook it. The genus is similar to *Cranchia*, excepting that the eyes are pedunculate, that the shorter perioral arms are aborted, and that the longer (so-called prehensile) arms are devoid of suckers. In the youngest stage observed there are two rows of suckers on the long arms and six isolated and pedunculate suckers surrounding the mouth, which appear to represent the shorter arms of other cephalopods.

**Gill in some Forms of Prosobranchiate Mollusca.**†—H. L. Osborn describes the gill-structure of several genera (*Chiton*, *Fissurella*, *Fulgur*, *Sigaretus*, *Crepidula*, &c.) of Prosobranchiate Mollusca.

In *Chiton* and in *Fissurella* the gills are leafy blades attached to a rachis and joined to the body only for a short distance, the base of this rachis; in the prosobranchs generally the gill consists of independent plates, each one attached to the roof of the mantle cavity, and not placed upon a stalk and borne free from the mantle wall. The few forms which are divergent from this plan of structure are readily seen to be only secondarily different from it.

The author briefly summarizes the results of his studies as follows:—The gill of *Chiton* and *Fissurella* is closely like the *ctenidium*, which Lankester considers the primitive type of molluscan gill. In ctenobranchs, almost universally, the gill is not a *ctenidium*, but a very much simpler organ. Its form compares closely with the gill which we have come to regard as the primitive lamellibranch gill. Incomplete study of ctenobranchs and ignorance of the history of the development of the ctenidia in *Chiton* and *Fissurella* prevent more than a conjectural conclusion. It does not seem, however, safe to accept the conclusions of Spengel and Lankester that the ctenobranch gill is derived from a feather-form gill like that of *Fissurella* by the fusion of one side with the body-wall.

**Kidney of Aplysia.**‡—J. T. Cunningham has recently cleared up the confusion that exists as to the position and relations of the renal organ in *Aplysia*. This organ—the "triangular gland" of Delle Chiage—is situated beneath the shell and behind the pericardial cavity; the reno-pericardial opening was demonstrated by injecting the pericardium with Berlin blue and cutting the kidney into a series of sections; by these means it was ascertained that the reno-pericardial opening was continuous with a canal running back through the substance of the kidney and opening below into its cavity. The external aperture of the kidney is situated below the line of attachment of the gill which traverses the surface of the organ, and close to its posterior extremity. In structure the kidney consists of a number of trabeculæ forming a network; in the interior of the trabeculæ are numerous blood lacunæ which are sometimes traversed by delicate strands of connective tissue; on either side of the trabeculæ are the renal cells, none of which appear to be ciliated. The kidney of *Aplysia* corresponds morphologically to the *left* kidney of Zeugobranchia and *Patella*.

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* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 311-8 (2 figs.).

† Stud. Biol. Lab. Johns Hopkins Univ., iii. (1884) pp. 37-48 (3 pls.).

‡ MT. Zool. Stat. Neapel, iv. (1883) pp. 420-8 (1 pl.).

**Visual Organs of Lamellibranchs.***—B. Sharp has examined the edge of the mantle of *Ostrea virginica* and *Mitilis edulis* of the Asiphonata, and the siphons of *Venus mercenaria*, *Mya arenaria*, *Mactra solidissima*, besides the forms already described for *Solen ensis* and *S. vagina*.† The pigmented cells found in these parts are essentially the same as those found in *Solen ensis* and *S. vagina*. The smallest of all the cells were found in *Ostrea*, and the largest in *Venus*. Experiments on these forms show their sensitiveness to light and shadow, and the cells showing the retinal character described leave little doubt as to the power of vision. No nerves could be demonstrated passing direct to these cells, and probably those distributed to the general epidermis serve in transmitting the impressions. The visual power is so low, that nerves have not been yet specialized for this purpose.

### Molluscoida.

**Development of Salpa.**‡—In the second part of his researches into the development of *Salpæ*, Prof. W. Salensky deals with four species, viz. *S. punctata*, *S. fusiformis*, *S. bicaudata*, and *S. democratica*; the differences observed between the species are very considerable, and a general *résumé* is given at the close of the memoir of the differences in all the species studied. The ovum is contained in a follicle which is a diverticulum of the respiratory chamber and connected with it by a canal, the so-called oviduct; in *S. pinnata* and others, this cavity disappears in time, but in *S. bicaudata* it persists as a brood pouch; the "oviduct" opens upon the summit of a fold of the walls of the respiratory cavity; in some species (e. g. *S. pinnata*, *S. africana*) another fold of the respiratory cavity of the mother rises round the aperture of the oviduct; these are termed *Salpæ thecogonæ*; in others again there is no such fold, and this group may be termed *Salpæ gymnogonæ*; corresponding to this difference are other differences both in the structure of the embryo and the development of its several organs.

In the first group the fold which immediately surrounds the aperture of the oviduct (*epithelhugel*) gives rise to the ectoderm of the embryo and to the wall of the placenta; the walls of the follicle are developed into the mesodermic organs of the embryo, the intestinal canal, pericardial cavity, and nervous system, together with the "roof" of the placenta and vascular tufts; in this group the oviduct is transitory and soon disappears.

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* Proc. Acad. Nat. Sci. Philad., 1884, p. 10. This is the same article which was given in brief abstract, *ante*, p. 213.

† See this Journal, *ante*, p. 39.

‡ MT. Zool. Stat. Neapel, iv. (1883) pp. 327–402 (6 pls.).

In the second group (*Gymnogonæ*) there is no outer fold; the inner fold (*epithelhugel*) is transitory and the placenta is formed from the follicle or is merely transitory and commences to degenerate by assuming the appearance of a protoplasmic network in which the separate cells are indistinguishable; the oviduct persists, either taking a share in the formation of the embryo (*S. democratica*) or serving as a brood cavity (*S. bicaudata*) for a short time and then disappearing.

The developmental process of *Salpa* is so peculiar that it is very difficult to compare it with other known types of development; the fact that the follicular cells take a share in the production of the embryo (the process of development being therefore both sexual and asexual) is not, however, confined to this group. Lankester has described a very similar state of things in Cephalopoda, where the "inner capsular membrane"—the follicle itself—grows into the ovum and partly forms the nutritive yolk; recent researches also into the Vertebrata tend to show that the yolk is partly formed from the cells of the follicle. *Salpa bicaudata* appears to represent the most simple development of all the species, while further complications, such as the formation of a part of the embryo by cells of the oviduct, tend to remove other *Salpæ* further from the normal mode of development exhibited in the animal kingdom.

**Budding of Anchinia.***—A. Korotneff has observed a colony of *Anchinia* to be covered with small corpuscles of two kinds, and with two modes of movement; one was wavy in outline, the other pyriform; the former had vesicular contents and moved rapidly by means of lobate pseudopodia, very much like those which are seen in such a form as *Amœba palustris*. In the second form the pseudopodia, which were confined to the narrower end, were fine and filamentar; their contents were compact and not granular, and there was an aggregation of corpuscles at their centre; they appeared to be completely analogous to the primitive buds found by Uljanin in *Doliolum*, and were not, as the other kind of bodies, unicellular, but multicellular. The author has been able to convince himself that the simpler are developmental forms of the more complex forms, and that the change is effected in the following way. The nucleus of the cell gradually divides, and at the same time the body of the cell loses its vesicular character and becomes finely plasmatic; a separation of ectoderm and endoderm is very early apparent; the cells of the body gradually grow, and endodermal cells with large vesicular nuclei become apparent—these form the future ovary, while the remaining three cells go to form the rudimentary intestine. As the ectodermal becomes separated from the endodermal layer, a lumen appears which is the true body-cavity.

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* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 50-61 (2 pls.).

The internal mass becomes divided into two sets of cells—the enteric and ovarian. The former becomes differentiated into the stomach and pharynx, and from the latter the endostyle soon becomes developed. The nervous system commences as a thickening of the ectoderm, which gradually becomes converted into an independent lens-shaped body, the ganglion. Within this ganglion a lumen arises which enters into connection with the lumen of the pharynx, in such a way that an outgrowth of the pharynx is directed towards the ganglion; this is the so-called hypophysis of the Tunicata. The nerve-ganglion grows out and forms a nerve-cord.

The author's observations on the development of the gills were not very complete, but he has been able to see that the cloaca forms two lateral outgrowths which bend round the intestine and become applied to the pharynx; the neighbouring cells of the latter grow rapidly in size and form special groups; where these groups are formed openings appear—the rudiments of the future gills. The mesoderm appear to have no other function in *Anchinia* than that of forming five muscular bands.

The ovarian cells, after having attained a certain size, undergo absorption; from them there appear to arise new cells, each of which has a large nucleus and soon becomes divided; the function of these is very problematical, but we have at present no right to regard it as being renal. After some further observations on the germinal cells, Korotneff passes to a discussion of the significance of the phenomena.

He commences by pointing out that the maternal organism to which the outgrowth and buds belong is completely unknown. We must, therefore, in any further discussion of the question, base ourselves on the analogy of the allied *Doliolum*. If this be justifiable, then we may suppose that the unknown mother had a rosette-shaped organ from which the primitive buds became separated; these are the parts which have given rise to the buds here described. The forms observed by Barrois and Kowalevsky were sexual, those seen by Korotneff had the genital organs reduced, and indeed only ovaries were detected by him. It would seem, then, that the maternal organism is of the second asexual generation, and we have then the following alternation. The problematical asexual generation which possesses a rosette-shaped organ, produces from the primitive buds special buds which are fixed on the outgrowth. On this follows a series of similar buds, which develope parthenogenetically until at last some of the buds give rise to sexual organs. These last, by sexual means, give rise to the first problematic individual. The case is complicated by the extension of the asexual stages, and is analogous to what obtains among Aphides.

The most remarkable of all the phenomena in the development of *Anchinia* is the change which has taken place in the relation of the organs to the germinal layers. The pharynx is developed from the endoderm, and the same layer gives rise to the heart. How are these very remarkable facts to be explained? We must either suppose that the germinal layers of the organism derived from the ovum are not homologous with those here described, or that the germinal layers have not, in the development of the different organs, the special significance that has hitherto been attributed to them.

**Morphology of Flustra membranaceo-truncata.***—W. J. Vigelius makes this essay an introduction to a proposed work on the morphology of the marine Bryozoa. The species of *Flustra* which he has examined offers another proof of the truth of the doctrine that the mode of growth of the Bryozoan stock is of no value as a means of distinguishing the families. The nutrient animal and the avicularium are alone distinctly differentiated individuals; the brood-capsules are only organs, not individuals. The nutrient animals may be (1) budding: these are found on the marginal zone of the colony; (2) perfect: these are the reproductive forms; (3) resting; and (4) decaying. The two last are only found near the proximal part of the stock, and are much rarer than the others. The cystid and polypid make up the complete nutrient animal, and in the normal condition consist of integument, nutrient apparatus, and parenchymatous tissue. The author has not been able to convince himself of the existence of a nervous system, but he thinks that its centre is perhaps represented by the small rounded mass of cells, which lies on the anal side of the anterior wall of the pharynx. Like other writers at the present time, the author has made some observations on spermatogenesis, and finds that the spermatoblasts are derived from the repeated division of the spermatospores, but they do not form rounded or oval masses of regularly arranged cells placed on a nutrient blastophore. Vigelius is uncertain whether the explanation of the absence of the blastophore is to be found in the occurrence here of a more primitive condition of things, or in the fact that the surrounding perigastric fluid is highly nutritious. When the spermatoblasts become converted into spermatozoa they are at first pyriform; the tail then arises at the narrow end, and becomes of some length.

The histolysis of the digestive tract is described, and the brown body is regarded as having certainly a nutrient function. The view that the cystid and polypid are parts of one and the same individual is supported by the observations of Barrois, the organization of the complete nutrient animal, and the history of the process of germination. The objection that the living cystid appears separately is of little weight, now that Vigelius has shown that the modifications of the cystid are not so numerous as Nitsche supposed—for example, the primitive avicularia are not cystids but polypocystids, the root-filaments are organs, and not individuals, and the same is true of the brood-capsules. As to the objections based on the periodical disappearance and subsequent regeneration of the enteric canal, an answer is to be found in the general dictum that morphological facts must not be looked at from a physiological standpoint, as well as in the fact of the wide distribution of the phenomena of regeneration among lower animals.

The perigastric space is regarded as being a true cœlom, but at the same time Vigelius adopts the view of the Brothers Hertwig, that the Polyzoa are pseudo-cœlia.

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* Biol. Centralbl., iii. (1884) pp. 705–21.

## Arthropoda.

### α. Insecta.

**Coræbus bifasciatus.**[*]—A. Laboulbène discusses the sexual differences of this Coleopteron, and the characters of its so-called eggs. He finds that the male has been mistaken for the female, and that the oviform bodies are true Acari, in the body of which developing ova were to be detected; the oviform body, then, is nothing but the globular abdomen of the mite, which is swollen out into a vesicle more like that of Termites or *Pulex penetrans* than anything which is found in any other acarid of the same family.

**Mouth Parts of Diptera.**[†]—The descriptive part of H. J. Hansen's work is preceded by a full historical account of the work of others, from Swammerdam to the recent writers, such as Dimmock, Becher, Meinert and Kräpelin. It is written in Danish, with a Latin abstract, or "Conspectus systematicus," of the chief results, and the explanations of the plates are both in Danish and Latin.

**Mouth-Organs of Lepidoptera.**[‡]—P. Kirbach, after an account of what is generally known as to the structure of the mouth-organs of insects in general, and of Lepidoptera in particular, proceeds to his own observations. With regard to the histological structure of the proboscis, he points out that the lowest portion is distinctly lamellar, and consists of thin transparent layers, while the upper portion has chitinous bodies deposited in its otherwise homogeneous ground substance; these bodies are set at pretty regular distances, and always have their broadest surface turned outwards. True scales, completely analogous to those of the wings and other parts of the body, are to be found on the maxillæ of many moths and of some butterflies.

The author has been interested in the formation of the rod-like bodies found within the closed sucking canal; he was at first inclined to ascribe to them a gustatory function, but this was opposed by their possession of a chitinous membrane, and by the presence of true gustatory organs within the mouth. Nor can they have an olfactory function, but must rather be tactile organs which test the fluidity and viscidity of the fluid—a not unimportant function, as the quantity of saliva that has to be mixed with the food depends on the degree of its viscidity.

In answer to the very interesting question as to how the sucking canal is formed, the author points out that, owing to the close apposition of the two maxillæ, a tube is formed through the whole length of the proboscis, and this is nearly circular. How are the maxillæ kept closely united and the canal so closed as to be air-tight without restraining the powers of movement of the proboscis? A series of closely-applied, thin, chitinous plates are inserted into the chitinous ridges which are placed near the sides of the groove; these plates are set horizontally and are much longer than broad; they are so arranged that the clefts between the separate plates are covered over as completely as possible; in *Vanessa*, the marginal plates are beset with lateral teeth. In *Pieris*, the last eighth of the proboscis has its plates smaller, and their course is oblique and upwards, instead of horizontal; the spaces between the plates are larger, but a compensation is afforded by the development of spines. The differences which obtain in various Lepidoptera are noted, but in all it is clear that a maximum of strength obtains with a maximum power of movement.

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[*] Comptes Rendus, xcviii. (1884) pp. 539–41.

[†] H. J. Hansen, 'Fabrica Oris Dipterorum,' part 1 (Tabanidæ, Bombyliidæ, Asilidæ, Thereva, Midas, Apiocera), 8vo, Copenhagen, 1883, 250 pp. and 5 pls. See Amer. Natural., xviii. (1884) p. 274.

[‡] Arch. f. Naturg., l. (1884) pp. 78–119 (2 pls.).

The mechanism of sucking may be thus described:—When a butterfly thinks it has lit upon suitable food it tests it with the tactile corpuscles of the protruded proboscis, and then slips the top of the proboscis into the fluid; with this it mixes a certain quantity of saliva. The frontal, lateral, and dorsal muscles contract, and so draw up the operculum of the pharynx; by this means a large cavity is formed. At the same time the elevator muscle of the oral valve contracts, and the oral and proboscidial canal are put into communication with the pharynx, which is almost empty of air. The pressure of the atmosphere drives the fluid into the canal of the proboscis. As the opercular muscles relax, the longitudinal and transverse muscles contract, and by this means the fluid is forced into the œsophagus. When the latter muscles relax, the opercular muscles come together, the œsophageal valve closes the hinder opening, the oral valve rises, and a second stream of fluid enters the pharynx. These acts follow one another so quickly and so regularly that a continuous stream enters the canal of the proboscis. It will be seen that the author's account differs from that of preceding writers, and he is, apparently, justified in contending that it is the only one which falls in with the anatomical facts.

**Malpighian Vessels of Lepidoptera.**[*]—M. Cholodkovsky has lately added *Tineola biselliella* to the list of the few insects that are known to have only two Malpighian vessels; these are of some size, and are folded along the course of the digestive canal, and end by a distinct enlargement. Suckow has described four Malpighian vessels in a species of *Pterophorus*, and of *Hyponomenta*, but later investigations show that they really agree with the great majority of the Lepidoptera in having six. As embryological research has shown that a small number of Malpighian tubules is a primitive character, and that with progressive development the number increases either by branching or by histolysis, succeeded by a fresh development of a larger number, it is clear that the Microlepidoptera in which there are but two, while their caterpillars have six, exhibit just the reverse to what we should expect—or, in other words, we have here a case of atavism, and one which, as it obtains in the imaginal state only, is a periodic rather than a constant atavism.

**Abdominal Muscles of the Bee.**[†]—G. Carlet distinguishes three regions in the abdominal musculature of the bee—dorsal, lateral, and ventral. All of them, with the exception of the alæ cordis, which subserve the function of circulation—and they are more numerous than is generally supposed—take part in respiration, and consequently in the production of heat, which is so important a function in the economy of the bee. The mechanism is more complicated than is ordinarily believed, for when the abdomen shortens or elongates the dorsal and ventral surfaces approach or separate from one another; in other words, the abdomen dilates or contracts along three axes to admit or expel air by its stigmata.

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[*] Comptes Rendus, xcviii. (1884) pp. 631-3.

[†] Ibid. (1883) pp. 758-9.

**Flight of Insects.***—Dr. Amans has a second essay † on the flight of insects, in which he describes the organs of the Orthoptera.

**Aphides of the Elm.**‡—J. Lichtenstein records some observations which have enabled him to establish the fact of the migration of the Aphides of the elm (*Tetraneura ulmi*) to the roots of grasses, and their return to the trunks of the trees in autumn.

### β. Myriopoda.

**Head of Scolopendra.**§—This memoir (in English) treats in detail of the external anatomy of the parts of the head in *Scolopendra subspinipes* Kohlr., as most typical of the Chilopods. The details appear to have been worked out with care, while the drawings seem to have been very carefully made by the author, and beautifully engraved.

In the course of his lengthy review of the works of his predecessors, the author criticizes and disproves Newport's views that the head of the Chilopods is composed of eight subsegments. Four pages of the memoir are devoted to an elaborate and useful tabular view of the opinions of forty-six authors as to the morphology and nomenclature of the mouth-parts. Dr. Meinert gives a new explanation and nomenclature of the mouth-parts. He also claims that they are analogous with those of biting insects, or, to use his own words, "it is purposed to serve me to show the coincidence of the head of Chilopoda and its parts of the mouth with the head of the Insect and its parts of the mouth, especially in the Orthoptera, that is to say, in insects with free biting parts of the mouth, and four pairs of these parts or four metamers in the head." He does not regard the antennæ and the antennal segment as homologues of the other mouth-parts and segments. In his own words, "The real head then must be said to consist of the three foremost metamers, together with their exponents or limbs; that is to say, the labium, the maxillæ and the mandibles, and besides of the lamina cephalica, which latter, as well as its appendages, the antennæ, I by no means can consider to be homonomeous with the other metamers of the body and of the head, and with their exponents."

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* Rev. Sci. Nat., iii. (1883) pp. 121–39 (2 pls.).

† See this Journal, iii. (1883) p. 832.

‡ Comptes Rendus, xcvii. (1883) p. 1572.

§ F. Meinert, 'Caput Scolopendræ. The Head of the Scolopendra and its Muscular System,' 77 pp. and 8 pls. 4to, Copenhagen, 1883. See Amer. Natural., xviii. (1884) pp. 270–2.

### γ. Arachnida.

**Skeletotrophic Tissues and Coxal Glands of Limulus, Scorpio, and Mygale.***—E. Ray Lankester points out the necessity for a detailed and comprehensive study of the connective and other tissues of the skeletotrophic group in both Arthropoda and Mollusca "before we can pretend to offer any satisfactory account of the vascular system in those groups, and of the 'lacunar' connection between arteries and veins, which is confidently described and discussed by all zoologists, but has never yet been demonstrated to exist in a manner satisfying the requirements of modern histology."

In the account of the structure of the entosternites, the author says that it seems possible to morphologically define "cartilage" by the isolation of each one of its constituent cells in a firm matrix, and by the triaxial multiplication of those cells, whether the matrix be homogeneous, fibrillated, or penetrated by reticular condensations. A well-marked entosternite has for the first time been found among the Crustacea, and, curiously enough, in the most archaic form, *Apus*. After a careful description of the various forms of connective tissue the author passes to the blood-corpuscles of *Limulus* and *Scorpio*, which agree remarkably in form, size, and granulation; both contain a large quantity of hæmocyanin, and are both, in bulk, of a deep indigo-blue colour.

The coxal glands are next dealt with; their minute structure points to their forming an active secretory apparatus, the materials for which are brought to them by the intercæcal tissue; they may well be compared with the green glands (antennary coxal glands) of the Decapod Crustacea, from which, however, they differ in having no definite outlet, and in the structure of the epithelial cells. The author justly points to the occurrence of "these glands in their characteristic position, and with their characteristic corticated secretory cells in *Limulus* on the one hand, and in *Scorpio* and *Mygale* on the other," as another argument in favour of that classificatory alliance of *Limulus* with the Arachnida, of which he has, in earlier essays, afforded so many instructive demonstrations.

### δ. Crustacea.

**Liver of Decapods.**†—J. Frenzel gives a short account of the results of his investigation of the gland of the mid-gut, or liver, of twenty-six species of Decapods. The epithelium of this gland consists of fat-cells and ferment-cells; the size of them does not seem to differ with that of the individual, but to be pretty constant in each species. In *Carcinus* they are ·07 mm. and in *Palinurus* ·06 mm. in diameter. In section, each tube of the gland is seen to be invested by a delicate fringe, which is more or less distinctly striated, and which has the function of a porous cuticle. The longitudinal striation seen in the upper part of the cells calls to mind that which obtains in the cells of the mid-gut of insects and of certain Crustacea. Within the cells there are spheres or drops, which vary in size and number, but almost always occupy nearly the whole of the cell; they are generally, though not always colourless, and their exact chemical composition has not been definitely made out, though they present in some cases the reactions of fatty bodies.

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* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 129–62 (7 pls.).

† SB. K. Akad. Wiss. Berlin, xlii. (1883) pp. 1113–9.

Between these cells lie others, the number of which varies considerably, but is always in direct relation to the nutritive condition of the individual. They present the same fringe and longitudinal striation as the fat-cells; the greater part of each is filled by the true secretion-bodies which are almost completely spherical, surrounded by a delicate membrane, and containing crystals which appear to be formed of tyrosin. When the ferment-cells are set free the vesicles and their contents make their way into the stomach and intestines. If the animal is in a normal condition the contents are gradually extracted and dissolved; but if the nutrition or digestion is in a disturbed condition, as is often the case with animals in confinement, then the ferment-vesicles pass almost unchanged from the intestine with the fæces.

The organ of the mid-gut cannot rightly be called a liver, for it has not that which is the prime characteristic of a liver—colouring matters, nor can bile-acids or bile-colouring matters be detected in its secretions. It is possible that the fatty cells also contain a ferment, but the presence of it has not as yet been definitely proved.

**'Challenger' Copepoda.***—G. S. Brady's report on the 'Challenger' Copepoda has just appeared; it contains a description of 43 new species and 11 new genera. One of the latter, *Pontostratiotes*, which contains but a single species *abyssicola*, is an undoubted deep-sea form, having been dredged in a depth of 2200 fathoms; it is characterized by an unusual development of spines upon the carapace and anterior antennæ; it is possible that a certain number of other forms, *Calanus princeps*, *Hemicalanus aculeatus*, *Phyllopus bidentatus*, which came up in the dredge from great depths, are also abyssal, but in these cases it is not positively certain that the specimens really came from the bottom. The other Copepoda were all taken in the surface net at the actual surface and at various depths below. Like most other pelagic organisms, the genera and even the species are very widely distributed. An accurate analysis of the localities in which all the species were obtained is given, and the geographical areas into which the ocean is divided are the same as those used in the report on the Ostracoda, viz. North Atlantic, South Atlantic, South Indian Ocean, Australasia, South Pacific, North Pacific, East Asia. Of the 90 free-swimming species here tabulated, only one (*Enchæta prestandreæ*) was found in all the seven districts, but no fewer than nine species occurred in all but one of the areas. The area producing the smallest number of species (15) is the South Indian Ocean; from the North Pacific the number is not much greater, 22. Leaving out of consideration the fish parasites, which were extraordinarily few in number, the largest number of species were obtained from the North Atlantic, South Atlantic, Eastern Asiatic, and Australasian seas.

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* 'Report, &c., H.M.S. Challenger,' Zoology, xxiii. (1883) 4to, 142 pp. (55 pls.).

The Arctic and Antarctic oceans seem more favourable to the growth of the Copepoda than other regions, the number and size of the individuals being larger here than elsewhere. The Tropical and Sub-tropical seem, however, to maintain the largest number of species and genera, though no one form is so abundant as is *Calanus finmarchicus* of the Polar seas.

The report contains a description of all the new species as well as of several others already known to science, and is illustrated by a number of woodcuts and 55 plates.

**Longipedina Paguri.***—W. Müller describes a new Copepod of the family of the Harpactidæ, for which he forms a new genus as above. It was found living parasitically on species of *Pagurus*.

**Cytheridæ.**†—W. Müller has some observations on the generative organs of these Crustacea. The penis is composed of a number of movably-connected chitinous ridges with bundles of muscular tissue; the differences presented by different forms are, probably, of greater interest to the systematist than the morphologist. The following table shows the relations of the parts in *Cypris* and *Cythere*:—

| *Cypris.* | | *Cythere.* | |
|---|---|---|---|
| *Female.* | *Male.* | *Female.* | *Male.* |
| Vagina. | Penis, hinder part? | Vagina, or rudimentary vagina (lobi abdominales). | Hinder part of penis. |
| | Penis. | External appendage of the rudimentary organ. | Penis, without hinder appendage. |
| | Mucous gland. | Rudimentary organ. | |

A list is given of the species found in the North and Baltic Seas, and a new genus *Cytherois* is formed for *C. virens* n. sp. It approaches, but is not so much modified as *Paradoxostoma* in the character of its mouth-organs; it is, however, clearly adapted for taking in fluid nutriment, the mandibles being unarmed, and there being no organs which serve to comminute the food.

**Deep-Sea Crustacea.**‡—Among the remarkable forms of deep-sea Crustacea collected by the 'Talisman' is one to which A. Milne-Edwards has given the name of *Nematocarcinus gracilipes*; it is distinguished by the extraordinary length of its antennæ, and by the attenuation of its ambulatory appendages.

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* Arch. f. Naturg., l. (1884) pp. 19-23 (1 pl.).
† Ibid., pp. 1-18 (2 pls.).
‡ Nature, xxix. (1884) pp. 531-3.

### Vermes.

**Development of Worm Larvæ.***—J. W. Fewkes has some rather scattered observations on the development of certain worms.

1. *Prionospio tenuis.* It is pointed out that defensive setæ or spines are only found on free-swimming annelid larvæ, and this fact leads to the suggestion that they are special organs for defence, rather than "ancestral features," descended from fossil forms, which, according to A. Agassiz, they sometimes closely resemble.

2. *Spio* sp. This larva is telotrochal, and has a large preoral lobe with an equatorial ring of cilia and embryonic spines, which arise from ear-like backward projections of the head. Scattered pigment-spots, but no cephalic eye-spots are present. When the larva is alarmed the spines on its body are raised, and project at all angles to their point of origin.

3. *Aricidea* sp. There is a resemblance to *Spio*, but also certain points of distinction; the oldest larvæ have the long provisional setæ, but not the other cephalic appendages of the larval *Spio*.

4. A polytrochal larva, taken about the end of the summer, had two flat circular ear-like appendages (" auricles ") on the sides of the head.

5. *Telepsavus* (?). The larval forms doubtfully referred to this genus are very common at Newport; it is so large as to be easily distinguished by the naked eye as it swims about in the water.

6. *Phyllochætopterus* sp. This larva closely resembles the preceding, but is distinguished by the absence of lateral cephalic tentacles.

7. *Nephthys* sp. The youngest larvæ have a great resemblance to those of *Polygordius*, but the pattern of colour on the anal pole is characteristic. A movement of the eye-spots from the head to the fourth body-segment was noticed, but the means by which it was accomplished were not quite clear.

8. *Lepidonotus squamatus* (?). The youngest larvæ were monotrochal.

9. *Nereis* sp. The mandibles were seen to be well developed at an early stage.

10. *Pilidium recurvatum.* This name is provisionally given to an interesting form, which has many structural relationships to *Tornaria* (*Balanoglossus*) and *Actinotrocha* (*Phoronis*). The interior of the larva is occupied by an œsophagus, and "an amniotic cavity, which contains a growing Nemertine worm"; the œsophagus is continued into the intestinal cavity of the young Nemertine. This form passes through a remarkable metamorphosis in which, however, no part of the nurse is unabsorbed, even the pigmented regions of the amnion being detected in an enlargement at the hinder end of the worm. The author regards this absorption of the larval envelope as one more characteristic pointing to the close affinities of the Nemerteans with the Echinodermata.

11. *Polygordius.* The Lovenian larvæ are among the commonest of those found at Newport; in the figures here given attention is

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* Bull. Mus. Comp. Zool. Camb., xi. (1883) pp. 167–208 (8 pls.).

directed to the peculiar brown bodies found near the "bell margin," which seem to be characteristic, and to the ventral nerve-cords which have never yet been represented.

12. *Capitella.* 13. *Lumbriconereis.* The jaws of this larva, when simplest, have a remote resemblance to the chitinous teeth of *Branchiobdella astaci.*

14. *Nectonema agilis*[*e*]. Some observations are made on this worm, the affinities of which are, as Verrill suggests, probably with the Nematoidea.

**Excretory Apparatus of Hirudinea.***—F. Vejdovsky gives some new facts respecting the segmental organs of leeches; these organs consist of a terminal vesicle into which opens a simple duct connected at its dorsal extremity with a gland consisting of a number of large cells traversed by a winding branched duct. In *Clepsine bioculata* and other species the central duct of the glandular portion of the organ breaks up here and there into a fine network. The whole of the segmental organ which has no cilia is surrounded by a rich network of blood capillaries in *Hirudo medicinalis* and *Aulostoma gulo ;* in *Nephelis* and other genera this vascular sheath is entirely wanting. The segmental organs of the Hirudinea resemble those of *Chætogaster* more closely than any other form; in neither is there a ciliated funnel or cilia developed along the course of the duct; the glandular portion of the organs is, however, but slightly represented in *Chætogaster*, and it is not known whether the duct is branched in this region. Both these families are degenerate Oligochæta, and the segmental organs are evidently traceable to the type found in Oligochæta and have no connection whatever with those of *Gunda* and other Planarians; the branched ducts of the latter are not comparable to the fine ramifications in the leech's segmental organs, since they are provided with independent walls, while the ramifications of the central duct of the nephridium in the Hirudinea are contained within the substance of the glandular cells themselves. An additional proof of the direct relation between the segmental organs of the Hirudinea and the Oligochæta is to be found in the close similarity of the development.

**Function of Pigment of Hirudinea.**†—R. Saint-Loup finds that when a young *Nephelis* has been eating, the three hinder portions of the four into which its intestine may be divided are covered on their surface with small yellowish-brown granulations which gradually become closely packed; they are arranged on the walls of the capillaries which, clearly, carry to the blood the digested food. In the adult the tunic of yellowish-brown spherules lies on the inner face of the musculo-cutaneous layer, but remains in relation to the intestine by means of the fine vessels which invest its walls. The author has been able to demonstrate the continuity between the yellowish spherules and the pigment-granules, and there appears to be in the Hirudinea a special excretory or pigmentary function in these yellowish-brown cells. A further question arises on the relations which exist between the pigmentary and the hepatic functions; with regard to the latter we have to note that in the Vertebrata, the liver has two functions; the first and most important is the reception of certain matters from the blood which are deposited in it; the second is the excretion of these products. The function of these parts may lie in separate organs, and Saint-Loup thinks that the former is, in the Hirudinea, effected by the cells which line the capillaries in contact with the intestine of *Nephelis*, and by the yellow globules which are found in the parenchyma of *Clepsine*. But the elimination is not effected by bile-ducts but by the pigments; the function of the bile as a fluid accessory to the digestive juices is performed by the secretion of the walls of the digestive tube.

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* SB. K. Böhm. Gesell. Wiss., 1883, pp. 273-80 (1 pl.).

† Comptes Rendus, xcviii. (1884) pp. 441-4.

The study of the development of the liver in certain invertebrates and in the vertebrata has shown that it is formed at the expense of the walls of the intestine, and sometimes from a diverticulum of it; the author thinks that, in the Hirudinea, it is formed not only by this portion of the intestine, but also by yellowish-brown spherules, and it is from this point of view only that we can give to the *tunica villosa* and homologous organs of worms the definite name of liver.

**Otocysts of Arenicola grubii.**[*]—E. Jourdan describes the otocysts of *Arenicola grubii* as being placed in the middle of muscular bundles at some distance from the hypoderm, and as surrounded by the connective envelope of these bundles. They are united to the œsophageal commissures by several nerves, and are placed at the side of the dorsal surface. The otocysts are always perfectly circular, and their cavity measures ·14 mm. in diameter, while the sphere itself is ·22 mm. in diameter, so that the walls are of some thickness. These walls are formed by a layer of fusiform cells, a plexus of fibrils, and a connective envelope. Only feeble indications of cilia could, with difficulty, be detected. The cells narrow at their base and curve about in various directions, anastomosing to form a very delicate layer of fibrils which, at the base of the epithelial layer, unite to form a zone intermediate between the nerve-fibres and the base of the cells. The otoliths, like the otocysts, are always spherical, but they vary greatly in size and number.

**Manayunkia speciosa.**[†]—E. Potts supplements Dr. Leidy's description of this genus (erroneously recorded as *Manyunkia* at p. 231) by former observations of his own, demonstrating its strictly freshwater habitat, the apparent grouping of the tentacles on two processes on the lophophores, and the difference in the effect produced by the motion of the cilia as compared with a polyzoon. In the latter a powerful "incurrent" bears food to the mouth as a vortex; in the former, while the motion draws the particles from without or behind the circle towards the tentacles, when they pass by them they are influenced by an "excurrent" bearing them forcibly away. A specimen isolated in a microscopic stage tank, for some reason, left its old tube and formed another, giving him the opportunity of observing the character of the latter, and the method of its construction. In its earliest stages it is a transparent, smooth, and homogeneous slime-like excretion, within which the worm may be very clearly seen, as it works its way forward or drags itself backward by means of its pedal hooks and spines. Later on, the anterior extremity thickens and becomes more and more opaque, and, as Dr. Leidy has observed, "feebly annulated," presumably from the adherence of effete particles, and their compression by the repeated withdrawal of the ciliated tentacles into the mouth of the tube. This method of prolongation must continue during the residence of the worm, and in consequence, if supported, it may sometimes reach a length which is several times that of its inhabitant.

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[*] Comptes Rendus, xcviii. (1884) pp. 757–8.

[†] Proc. Acad. Nat. Sci. Philad., 1884, pp. 21–4.

Miss S. G. Foulke has also examined * the worm and describes the pulsation of the green tentacles.

To ascertain how long the cilia upon the tentacles would continue their motion after separation from the body of the worm, both lophophores of an adult were cut off above their junction.

At first the tentacles remained closed from the shock, but soon they were expanded, the cilia displaying active motion, and presently the two separated lophophores began to move about in the zoophyte trough. This motion was produced by the action of the tentacles, which bent in all directions, the tips touching the glass, and was not a result of the currents produced by the cilia. In a few minutes one lophophore had *crawled* in this manner quite across the trough, while the other remained floating in the water near its first position. In the case of this latter the motion was produced by the ciliary currents, and was entirely distinct from the crawling above noted. During this time the decapitated worm had sunk to the bottom, and, though turning and twisting a good deal, did not attempt to protrude the mutilated support of the lophophores. Its body was so much contracted that the segments were not above one-third their usual size.

At the end of five hours the worm was apparently dead, numbers of infusoria had collected to prey upon it, and the surface of the body presented a roughened appearance as though covered with tubercles. The lophophores were still crawling and swimming about. At the end of the eighth hour the lophophores had ceased to crawl, but the ciliary action, though feeble and uncertain, still continued. The body of the worm was then covered with a thick fungoid growth, consisting of transparent rod-like filaments 3/16 in. in length; some of the filaments presented a beaded appearance. All motion of the cilia upon the tentacles had ceased, and these also were being devoured by infusoria.

**Life-History of Thalassema.**†—H. W. Conn describes (in a preliminary paper) the early stages of development of *Thalassema mellita* that inhabits empty "sand-dollar shells." Its anatomy is much the same as that of *Echiurus* described by Sprengel. It is diœcious. The ova and mother-cells of spermatozoa are simply modified cells of the peritoneal lining of the body-cavity, in which, whilst developing, they float freely, being driven, when mature, into two sexual pouches at the anterior end of the body.

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* Proc. Acad. Nat. Sci. Philad., 1884, pp. 48–49.

† Stud. Biol. Lab. Johns Hopkins Univ., iii. (1884) pp. 29–35 (1 pl.).

In about fifteen minutes after fertilization two polar globules are protruded from the egg, exhibiting a rhythm precisely similar to that of the segmenting ova. Segmentation is, exceptionally among Annelids, perfectly regular and uniform. About the 6th hour a gastrula is formed by a typical invagination, and at the same time the region opposite the blastopore becomes marked off as the anterior extremity and already functions as a head. A preoral band of cilia appears and is subsequently replaced by a *row* of longer and more powerful cilia. The transformation of the gastrula into a trochosphere larva takes place by a peculiar method of growth whereby the direction of the long axis is changed. The mesoderm has a dual origin resulting in two different systems. First there is formed the two mesodermal bands so common to Annelid larvæ, and the second part of the mesoderm consists of a large number of unicellular muscles that separate from the endoderm at the time of the invagination, having thus an origin very similar to that of the mesoderm in Echinoderms.

Three other ciliated bands soon make their appearance, one immediately behind the mouth, a second just in front of the anus, and a third is found upon the ventral median line in precisely the place where the ventral nerve-chain is to arise. It is thus seen that both the cerebral ganglion and the ventral nerve-chain are preceded by the development of cilia from the very cells from which the nervous elements are to arise, an interesting point as indicating that already these cells are differentiated as nervous elements, although at first there is no trace of any nervous system. The further changes observed were the segmentation of the mesodermal bands and the origination of the ventral nerve-cord from the ectoderm as a bilateral structure.

**Spermatogenesis and Fecundation in Ascaris megalocephala.***— P. Hallez finds that the spermatospores of *Ascaris megalocephala* are at first formed of a homogeneous, extremely transparent, and nucleated protoplasm. Increasing in size they give rise by division of the nucleus to four protospermatoblasts which become separate. These similarly produce a second generation of cells—the deutospermatoblasts, and have a central blastophore in young, though not in old, males. When the deutospermatoblasts attain to a size of 6 μ in diameter their protoplasm, which was before homogeneous, becomes finely granular. When they have a diameter of about 18 μ they divide into two, and henceforward their protoplasm is filled with refractive granules. Before they pass into the seminal vesicle the spherical cells conjugate by pairs, and the nuclei fuse with one another. Two cells again separate, and at this moment corpuscles like polar globules are to be observed; these, which the author calls waste-corpuscles (*corpuscles de rebut*) finally entirely disappear.

The deutospermatoblasts are then introduced into the organs of the female, and are at this time 18 to 19 $\mu$ in diameter, spherical in form, having their protoplasm filled with refractive granules, which call to mind the vitelline granules, and they have a nucleus which is easily stained. In the female organs the refractive or nutrient granules diminish gradually and finally disappear. The deutospermatoblasts now present the most varied forms, and look more like *Amœbæ.* It is at this time they become spermatozoa, the substance of which is formed from the interior of the cells, and appears first as a differentiation of the protoplasm, and surrounded by a delicate granular layer —the remains of the deutospermatoblast; it is remarkable that the deutospermatoblast is constantly outside the spermatozoon. This latter has at first the form of a rounded cylinder, but its surface rapidly becomes spiral and one end enlarges as the other diminishes.

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* Comptes Rendus, xcviii. (1884) pp. 695-7.

At the moment of fecundation the ovum is surrounded by a finely striated zone, to which the conical spermatozoon becomes attached by its base; the yolk contracts slowly, the spermatozoon enters, but there is apparently no micropyle; the peripheral part of the yolk forms a granular zone which surrounds the male element, part of which advances as a fusiform male pronucleus to fuse with the female pronucleus. The yolk again contracts and a polar globule is formed.

**Structure of Derostoma Benedeni.***—P. Francotte, after an historical review of the characters of the genus *Derostoma* and its rhabdocœlous allies, gives a short diagnosis of the new species he has discovered at Andenne, where it was found in a stream, in the midst of a number of *Tubifex rivulorum* on which it feeds. In the anterior part of the body the epithelial cells are higher than elsewhere, their cilia are longer, and between the cells the ends of nerve-fibres could be detected, though their exact relations were not made out. The pharyngeal bulb is largely formed of muscular fibres, and is moved by a set of thick fibres which are attached to its dorsal and ventral surfaces and so produce movement in all directions. The muscular fibres in all parts of the body are smooth and non-nucleated; they appear to be formed of a large number of delicate fibrils.

When a specimen has been rendered transparent it is possible to see, in the anterior region, two ganglia united by a transverse commissure; each of these ganglia gives off two nerves which pass to the epithelium, and two others which are longer and pass backwards to innervate the various organs of the body; on the ventral surface of the worm there is yet another pair of nerves. The two ganglia and the commissure are formed externally by ganglionic cells, while the centre is filled with nerve-fibrils; on the course of the nerves large nerve-cells, similar to those of the central nervous system, are not rarely met with. The cells which line the digestive tract are stated to be globular during digestion, and to be elongated in sections made from fasting specimens.

The penis is not, as in some species, chitinous, but is formed of muscular fibres. Between the ovary and the receptaculum seminis there is a cæcal glandular tube, which appears to be a degenerating ootype, which now probably serves as the organ which secretes the fluid which, on hardening, forms the chitinous shell of the egg. In addition to what the author has already discovered in the characters of the excretory system, he is now able to state that the large trunks are formed of flattened clear cells, that the lacunæ are filled with corpuscles, and that there are very delicate canaliculi, without any proper wall, which unite the lacunæ with one another. In opposition to Lang, the author still regards these lacunæ as representing a true cœlom. Hæmoglobin has been detected in the anterior part of the body.

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* Bull. Acad. R. Belg., vi. (1883) pp. 723–35 (1 pl.).

**Opisthotrema, a New Trematode.***—P. M. Fischer describes a new Trematode, which he calls *Opisthotrema cochleare*, and which was taken from the tympanic cavity of *Halicore dugong*; it is remarkable for the characters of its generative organs, and especially for the fact that they open at the hinder end of the body—hence the generic name. These openings are separate from one another, ventral in position, and placed at the base of a circular pit with well-defined margins.

The testes are paired and symmetrical, rounded in form, but more or less distinctly lobed at their periphery; as the production of spermatozoa increases, the lower segment of the testes approaches nearer and nearer to the ventral surface. The testes consist of tubes, often closely packed, and bounded by a homogeneous structureless envelope, which is, apparently, a direct continuation of the cuticle. The separate tubes are connected together by a fibrous connective tissue, and are covered by a common envelope which appears to be of the same structure as that of the separate tubes. In young examples, naked, epithelial, finely granulated cells are to be found within the tubes; these, by division, give rise to the cells which, in older forms, are found grouped into rosettes: with these are associated thick cords of compressed mature seminal filaments.

Like the testes, the seminal ducts are paired, and have the common testicular investment continued on to them, while the extremely delicate muscular layer is now better developed. As the ducts enter the penial sheath they become united, and their lumen widens out, being here homologous to the so-called vesicula seminalis anterior of other Trematodes; the width of the coiled tubes varies with the maturity of their contents. The penis is so arranged that, on its extension, there is a pressure on its cavity and on the full seminal reservoir, the contents of which are thereby forced into the vagina. The penis has no armature of spines.

As in other Trematodes, the unpaired ovary is followed by the yolk-glands and the complex of shell-glands; connected with the oviduct is a receptaculum seminis, which is of very regular ellipsoidal form in young, though not in old individuals.

In discussing the mode of fertilization of the Trematoda, the author points out that there may either be self-impregnation or conjugation with another individual. The former may be effected by a third vas deferens, or there may be self-copulation, the erected penis being received into the adjoining female duct, or, lastly, the genital cloaca may come into function, its opening to the exterior being closed by muscles, the contraction of which drives the expelled sperm into the vagina. As to the form now under consideration, we know that there is no third vas deferens, and that the penis would have to be extraordinarily bent to be able to enter the adjoining female orifice; while, finally, the absence of a genital cloaca excludes the possibility of self-fertilization by its aid. The author describes the mode by which he supposes two of these hermaphrodite Trematodes may fertilize one another.

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* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 1–41 (1 pl.).

The system of excretory vessels may be, in Trematodes, ordinarily divisible into three parts; the first of these, the central organ, which is distinguished from the other parts by its muscular investment, was not detected in the new genus. At the hinder pole of the body there are to be seen two well-developed canals, which pass forwards and are, at about the middle of the body, provided with lateral branches, two of which are much longer than the third; from these there again arise fresh lateral branches, which end blindly and never anastomose with one another; these ducts are bounded by a doubly-contoured membrane, which is regarded as being certainly a continuation of the external cuticle. Within this, and, especially, applied to its walls, are granules of some size, and high refractive power. The author was unable to detect the ciliated infundibula described by Fraipont and Pintner.

In his account of the nervous system, Fischer directs attention to structures which appear to represent ventrally placed and peripheral ganglionic cells, the presence of which is of especial interest when we know that the ventral body-muscles are particularly well developed in this form.

The parenchyma of the body is composed of cells which vary greatly in form and appearance; at the anterior pole of the body they are smaller and rounder than at the hinder end; when largest, they have a striking resemblance to those of plants.

The specimens for examination were hardened in absolute alcohol, coloured with picrocarmine or hæmatoxylin, sometimes with an ammoniacal solution of carmine. They were rendered transparent by oil of cloves, and by being set up in Canada balsam and chloroform for permanent preparation, or in glycerine when the sections were not intended to be preserved.

**Polycladidea.***—A. Lang has published the first half of his monograph on these worms. It will be remembered that the author has divided the Turbellaria (the Nemertinea being excluded) into Polycladidea, Tricladidea, and Rhabdocœlida. He now subdivides the first suborder into two tribes:—I. *P. acotylea*, where we have the three families of Planoceridæ, Leptoplanidæ, and Cestoplanidæ; and II. *P. cotylea*, including the Anonymidæ, Pseudoceridæ, Euryleptidæ, and Prosthiostomidæ. He arranges the bibliographical portion under epochs; the first of these begins with O. F. Müller, 1774 (or Stroem, 1768), and ends with Mertens 1832. Mertens begins and Quatrefages (1845) ends the second period; the third ends with Keferstein in 1868; and the fourth with Graff in 1882. In all, we have the titles of 153 books and papers.

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* Fauna u. Flora des Golfes von Neapel, Monographie xi. (1884) part i., 240 pp. (24 pls.).

The work proper commences with an account of the methods of investigation; the best preparations were obtained by the following means:—

Prepared animals were placed for from 3 to 14 days in picrocarmine; much of the picrin was then removed by alcohol of 70 per cent.; they were then placed for from one to four days in Grenacher's borax-carmine, and then in feebly acidulated alcohol. In this way the protoplasm was distinctly coloured by picrocarmine, and the nuclei by the borax-carmine, while the long-continued action of the former produced a slight maceration, which was an extraordinary assistance in making out the boundaries of the cells. Mayer's cochineal method is the best for the investigation of glands. As usual, Beale's carmine was very successfully used.

A general review of the organization of the Polycladidea leads to a series of chapters in which the different organs are discussed; the epithelial investment, which is always very distinctly marked, and consists of more or less high cylindrical cells, is separated from the tissues of the body by a resisting basal membrane, and is always covered with closely packed and relatively short cilia, which are set on a resisting cortical layer of the cells, which may be regarded as the cuticle.

Contrary to what happens in most Triclads and all Rhabdocœlids, the "rhabdites" always lie in the epithelium and never in the parenchyma of the body; and this is the most primitive arrangement. The mucous rods or pseudorhabdites are next considered; those found in the Triclads differ in many important points from the similarly named parts found by Graff in the Rhabdocœlidæ. Some forms are very elegantly coloured. True nematocysts are known in one species only, and the calcareous bodies described by Schmarda do not seem to have a real existence.

In the next chapter the dermomuscular system is first dealt with; the external layer of diagonal fibres on one side of the body is shown to be the direct continuation of the internal layer of the opposite side. Suckers are of two kinds; the first, found in all the *Cotylea*, is to be distinguished from those which, in the Leptoplanidæ, lie between the generative orifices, and have clearly a relation to the reproductive function. Dorsoventral muscular fibres are ordinarily well developed. All the fibres of the Polycladidea are thin, elongated, more or less highly refractive, and exhibit no differentiation into an axial substance and a peripheral layer. The dorsoventral fibres are delicately branched at either end, but this would not seem to be the case with those of the dermal system, except in the walls of the suckers.

The body parenchyma is next described, and it is stated that

Minot and Hallez are quite right in believing that the interspaces between all the organs are completely filled up with this substance; the appearance of spaces, such as was seen by Keferstein in his sections, is obviously due to imperfect conservation.

In the chapter on the digestive apparatus we have an account of the external mouth of the pharyngeal pouch, which is separated from the intestine by a "diaphragm," and of the pharynx, the origin of which is explained by some diagrammatic figures; the gastro-vascular apparatus, as the rest of the digestive tract is called, is described in considerable detail; the functions of this region would appear to be manifold, for not only has it a digestive function, but Lang agrees with Graff in ascribing to it a respiratory one also.

The investigation of the excretory or water-vascular system was attended with considerable difficulties; the author was able to convince himself that no connections obtained between the central cavity of the excretory cell and the lacunæ in the parenchyma of the body. On the whole, this system in the Polyclads agrees with the typical arrangement of other Turbellaria and of the Platyhelminthes; its highly ramified condition is to be explained as due to the absence of a special body-cavity and of a blood-vascular system. "The excretory system is compelled to seek out the excretory products in every part of the body."

The historical review of what has been taught as to the nervous system, similar to that which precedes the discussion of all the organs, is of considerable length. The cerebrum is a transversely oval mass of some size, and is indistinctly divided behind into two lobes; it gives off a number of nerves which are large in proportion to its size, so that the origin of these is somewhat difficult to follow out. At a short distance from the cerebrum the ten strongest nerves are all connected by a commissure; the six anterior nerve-trunks soon branch and anastomose; the two longitudinal trunks give off a number of trunks which supply all the hinder parts of the body, and, like the rest, are connected by a number of anastomoses. The ganglionic cells of the central organ may be multi-, bi-, or unipolar, and vary considerably in size; the largest are the multipolar, and these are larger than any other cells of the body, with the exception of the ova; the nucleus is in all cases large and vesicular. The central part of the brain is occupied by a finely fibrous substance, in which no nuclei or ganglia can be made out, and the constituent fibres anastomose with one another. The nerves themselves are composed of extremely delicate fibres, which are only feebly stained by reagents.

The sensory organs may be tactile, optic, or auditory; all the Polycladidea do not possess tentacles, for they are absent in the Leptoplanida and the Cestoplanida; some of the former have, however, rudimentary tentacles. The tentacles may be either dorsal in position and confined to the anterior part of the body ("nape-tentacles"), or they may be marginal. In the Planocerida the former are always movable, and in all cases they may be regarded as parts which have been inherited. The marginal tentacles, on the other hand, are structures which clearly have arisen since the Polyclad-stock was differentiated, and are to be referred for a cause to the creeping mode of life of these worms; some of these marginal tentacles have the form of a fold, and are indeed nothing more than permanent folds of the anterior margin of the body in which the primitive (and in *Anonymus* the persistent) sensory organs were more numerously aggregated. From these folded tentacles the pointed ones appear to have been derived. Auditory organs have been found only in *Leptoplana otophora*. In addition to the special organs, it is to be noted that the whole surface of the Polyclad body is extremely sensitive.

In the tenth chapter the author commences, but does not complete his account of the generative organs, a notice of which must therefore be postponed till the second part of this important work is published.

**Early Stages in the Development of Balanoglossus.***—W. Bateson describes with great minuteness the early stages in the development of an undetermined species of *Balanoglossus*, up to the formation of the layers and the commencement of the nervous system. Especial stress is laid on the points of difference between this larva and *Tornaria*. The *Balanoglossus* larva is opaque, has no preoral or longitudinal postoral bands of cilia, water-vascular system, eye-spots, or contractile string, thereby differing remarkably from *Tornaria*, which it resembles on the other hand in the possession of a transverse band of cilia and an apical tuft of cilia. A striking similarity is observed to exist between the general history of the early development of this larva, and that described by Hatschek for *Amphioxus*, this resemblance being more particularly strong in the situation and mode of origin of the central nervous system and of the mesoblastic somites.

**New Rotatoria.**†—Dr. E. v. Daday, after devoting several years to the study of the Hungarian Rotifera, especially those of Transylvania, in 1882 visited the groups of pools in the Mezöséy, and found in the Mezö-Záher pool several new species, one of them representing a new genus.

*Brachionus Margói* n. sp. most nearly approaches *B. amphiceros*, especially as regards the processes of its carapace; but in that species the processes are all of equal lengths, while they differ in length in the new one. The essential distinction between the two species is to be sought in the rotatory organ, the musculature, the jaws, and salivary glands.

*Schizocerca* n. gen. *S. diversicornis* n. sp. resembles *Brachionus* in internal organization, but differs so much from the Brachionea, and, indeed, from all Rotatoria, in the structure of its foot, that the author regards it as the type of a new genus.

*Asplanchna triophthalma* n. sp. is one of the largest of the Rotifera, and very similar to *A. Sieboldii* (*Notommata Sieboldii* Leyd.) in the form of the body, the digestive apparatus, and the ovary. But the nervous system, the aquiferous vessels, and the construction of the rotatory organ show such considerable differences that the author has no hesitation about separating the two species, and he gives the new one the name of *A. triophthalma*, because besides the frontal eye, seated upon the œsophageal ganglion, it possesses two other smaller eyes placed at a distance from the ganglion, and provided with visual nerves. The male of *A. Sieboldii* possesses on each side of its body a triangular process; but no such appendages occur in the male of the new species.

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* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 208-36 (4 pls.).

† Math. Naturwiss. Ber. aus Ungarn, i. p. 261. See Ann. and Mag. Nat. Hist., xiii. (1884) pp. 309-10.

### Echinodermata.

**Echinoderm Morphology.**—Dr. P. Herbert Carpenter,* and W. Percy Sladen,† have essays dealing respectively with the apical system of the Ophiurids, and the homologies of the primary larval plates in the test of brachiate Echinoderms. The latter sketches the difference in the history of the development of the different groups, after noting that during growth there is a more or less centrifugal movement of plates, and that there are two natural sets of plates—a basi-oral or interradial, and a radio-terminal or radial series. In the earliest stages of the Crinoid the former primarily constitutes the whole calyx; during growth the radial series developes with disproportionate rapidity, and at a comparatively early stage predominates over the basal series. In the Ophiurid the radials are formed first, and the basals appear later. In the Asterid, as in the Crinoid, there is a retarded radial growth. In both Asterid and Ophiurid the outer plate of the retarded series appears earlier than the inner, and in both the representatives of the under-basals are not formed until the other plates are well developed. Sladen thinks the facts now known point to the conclusion that the Ophiurid is derived from a more highly developed Crinoid than the Asterid, which arose from a more primitive ancestor, and the two forms have advanced along collateral lines of descent. In both Asterids and Ophiurids, plates—the terminals—are found at the end of the arms, which are apparently without any homologues in the Crinoid. Dr. Carpenter urges very strongly the use of a reasonable terminology in the description of Crinoids. Against the view that the under-basals represent the dorsocentral plate of the young urchin, he puts forward the additional argument that not only has *Marsupites* a dorsocentral plate as well as under-basals, but the same is true of some Asterids and Ophiurids.

**Development of Comatula.**‡—E. Perrier recognizes three phases in the life-history of *Comatula*—the Cystidean, Pentacrinoid, and free Comatulid.

At the end of the first phase the young has no buccal tentacles or arms, its digestive tube forms a half-spire, and there is an anus at the side of the body. A U-shaped tube serves to introduce water into the tentacular apparatus, but it is not certain that it is the homologue of the sand-canal of other Echinoderms. The stalk contains six cords of cells, one of which is central, and is prolonged into the swollen part of the body, so as to occupy the axis of the spine formed by the digestive tube; it occupies just the same position as the sand-canal of Echinids. The swollen upper portions of the other five cords give rise to the chambered organ. The arms do not appear simultaneously, but successively.

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* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 1–23 (1 pl.).

† Tom. cit., pp. 24–42 (1 pl.).

‡ Comptes Rendus, xcviii. (1884) pp. 444–6.

In the Pentacrinoid stage, in which there is no trace of a vascular system, the axial organ retains the histological structure of the ovoid organ of the preceding phase; the cirri arise from the central cord of the stalk, and the arms from the five peripheral cords. In the last phase, the axial organ, which has the structure of the sand-canal of Asterids and the position of the similarly-named canal in Echinids, is clearly seen to have a nutrient function in relation to the cirri.

**Pharynx of an unknown Holothurian.***—Prof. H. N. Moseley minutely describes the pharynx of an unknown Holothurian belonging to the Dendrochirotæ, in which the calcareous skeleton is remarkably developed.

The specimen was dredged in the Sulu sea, no traces being found of the body to which it belonged. It measures about 1⅜ in. in length, thus exceeding in size any of the previously known examples with which the author compares and contrasts it. Additional interest attaches to its possible palæontological significance as the publication of the present account and figure may lead to the recognition of fossil Holothurian remains hitherto undetected.

## Cœlenterata.

**Mesenterial Filaments of Alcyonaria.**†—The chief results arrived at by E. B. Wilson from a study of the structure and development of the mesenterial filaments in numerous Alcyonaria are as follows:—

The six short filaments are formed as local thickenings of the septa, the rudiments appearing often before the breaking through of the stomodæum and "while the invaginated ectoderm was still everywhere separated from the entoderm by the supporting lamella"; this shows clearly that these filaments are of entodermic origin, though later they become continuous with the inner ectodermic wall of the œsophagus. It appears from the investigations of the Hertwigs and Krukenberg that these structures are the only organs of digestion, and this result is abundantly confirmed, diatoms and other foreign bodies being continually seen within the substance of the entodermic filaments, and occur within the entoderm-cells covering the septa or the dorsal filaments.

The two long dorsal filaments, on the contrary, are purely ectodermic in origin, being downgrowths from the stomodæum; the structure of these filaments is quite different from that of the entodermic filaments; the dorsal filaments are concerned in the production of currents, the cilia always working upwards. The dorsal filaments are developed earlier and more rapidly in the buds than the entodermic filaments, and the reasons for this are to be sought in the

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* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 255–61 (1 pl.).

† MT. Zool. Stat. Neapel, v. (1884) pp. 1–26 (2 pls.).

"physiological conditions existing in the bud and not in the egg embryo," where the entodermic filaments are the first to be developed; this condition is evidently the need for food; the bud embryo, unlike the egg embryo, has no deutoplasm, and is therefore dependent upon food brought to it from the nutritive zooids; thus the early development of the dorsal filaments which, as already stated, serve as circulatory organs; and since the nutritive supply must evidently come from below, the currents produced by the dorsal filaments work upwards.

The paper concludes with some general comparisons which are of the highest interest; it is suggested that the dorsal filaments are not merely the analogues but the homologues of the alimentary canal of higher animals; if the two became fused "we should have a digestive tube surrounded by closed cavities, in the walls of which are developed the muscles." This fusion does actually take place temporarily during digestion, and in *Alcyonium* the filaments appear sometimes to fuse permanently. In this case the "radial chambers of an Anthozoan correspond to the mesodermic diverticula of Enterocœla," a view which has already been set forth by several morphologists. With the exception of the Haimeida, all Alcyonaria show a marked bilateral symmetry, and the radial chambers may be considered as the unpaired diverticula and a series of lateral paired diverticula; the latter may perhaps be compared to the somites of segmented animals. It is well known that a ciliated groove exists on the ventral side of the œsophagus, and if this portion were to become separated off from the rest of the œsophagus and the mesenterial filaments fused, the result would be an "animal with a stomodæum and proctodeum, a closed mesenteron, and paired mesoblastic somites."

**Anatomy of Peachia hastata.***—M. Faurot recommends that this Anthozoon be first rendered insensible by water charged with carbonic acid. He finds twelve mesenterial folds, perforated at the level of the œsophagus; two neighbouring folds, instead of floating freely in the general cavity, unite to form a grooved organ, which has externally the appearance of a papilliform lip, and ends in the general cavity a short distance from the inferior orifice, which *Peachia*, like *Cerianthus*, possesses. Eight muscular bands project on the internal wall; these are arranged by pairs, so that four only of the twelve chambers are provided with them. These four chambers are placed asymmetrically, two of them being situated on either side of the grooved organ, and the other two being set opposite, on an axis perpendicular to that which passes through the papilliform lip and the inferior orifice.

**Ephyræ of Cotylorhiza and Rhizostoma.**†—C. Claus has been able to study a swarm of *Cotylorhiza* in all stages of the Ephyra phase; the youngest were from 1½ to 2 mm. in diameter, with eight long slender lobes, the cleft pieces of which were rounded rather than pointed. They are to be distinguished from the ephyræ of *Aurelia* or *Chrysaora* by the yellow algal cells, which, when accumulated in the radial canals, give rise to the appearance of two streaks in each of the main lobes, by the numerous spindle-shaped crystals which are found in the terminal division of the ocular lobes, and by the large size of the intermediate radial vessels. During growth the umbrellar disk of the larva grows out of proportion to the eight lobes, new structures appear on the buccal part of the oral tube, which seem to be of great importance in the future rhizostomatous condition of the animal. A closed annular canal is developed. Buccal tentacles appear in the Cannostomous stage, and their early development may be regarded as the "primary process superinducing rhizostomism"; this is then followed by the peculiar form of the four arms with their extended distal margin, and these by paired foldings of the brachial processes.

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* Comptes Rendus, xcviii (1884) pp. 756–7.

† Arbeit. Zool. Inst. Wien, v. (1884) pp. 175–83.

The chlorophyll-corpuscles already mentioned are regarded as belonging to symbiotic algæ, and the balls they form are thought to be due to the continued division of a single cell; they are present in such quantities, that one is tempted to suppose that there is no independent animal nourishment, but that the superfluous assimilation-products of the algæ are sufficient to support the medusæ. After long search, Claus has found Rhizostomata in an Ephyra-stage, but he is anxious for smaller and younger specimens than those which measure 3½ mm.

## Porifera.

**Calcisponges of the 'Challenger' Expedition.***—This, the first report on the 'Challenger' representatives of any group of sponges, is from the pen of a Russian naturalist, Dr. N. Poléjaeff. The Calcarea were considered by Häckel as essentially littoral forms, and the fact that two species were found by the 'Challenger' at a greater depth than 100 fathoms (viz. 450 fathoms, off the Azores), scarcely invalidates this conclusion, and at the same time accounts for the small number of species (30, of which 23 are described as new) obtained by the expedition.

A great importance attaches to the report from the fact that the author, having well-preserved materials and considerable time at his disposal, and a good training in the subject, has devoted himself to making the first thorough examination of the anatomy, and of the principles of a natural classification, since Prof. Häckel brought out his memorable work, the 'Kalkschwämme.' With regard to his predecessor's results, he is led to the conclusion that, although Häckel's "natural system" may be more natural than his "artificial" one, it is still very far from absolute agreement with nature; a conviction which has been more or less strongly felt by other observers. He rejects Häckel's system of defining the genera solely by spicular characters, pointing out that they are too variable for the purpose. Considerable alteration is found necessary in Häckel's account of the canal system. Thus, the assertion that inter-canals (the incurrent canals leading from the pores) of the *Sycones* are wanting in a large proportion of these forms, is shown not to hold for a number of these very species, and hence is probably untrue of all. Again, the "dendroid," "retiform," and "vesicular" modifications of the canal-system described by Häckel in various *Leucones* are in reality not present there. Poléjaeff agrees with Vosmaer in regarding the radial tube of the *Sycones* as simply a form of flagellated chamber, and not, like Häckel, a "person" equivalent to an individual *Ascon;* the *Olynthus* is simply a common form, out of which may be developed, by different processes, either a *Sycon* or an *Ascon*, the mesoderm in the former being more developed than in the latter, and thus giving capacity for a more differentiated canal-system. From their minute characters, in combination with Von Lendenfeld's observations on *Aplysinidæ*, he is led to ascribe the function of receiving food to both the ecto- and entodermal pavement-cells of the canals.

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* 'Report, &c., H.M.S. Challenger,' Zoology, xxiv. (1883) 76 pp. (9 pls.).

The mutual relations of *Leucones* and *Sycones* are elucidated by the discovery of a *Sycon* (*Amphoriscus elongatus*) in which the radial tubes, instead of opening directly and singly into the cloaca, debouch by groups of three, four, or more, into secondary chambers which in turn open into the common cloaca; the secondary chamber has only to be exaggerated to form the excretory canal which leads from the flagellated chambers of a *Leucon;* the skeleton of the radial tube of this and other primitive *Sycones* is non-articulated, i. e. does not form a succession of septa in the parenchyma surrounding the tube, and thus affords another point of connection with the similarly circumstanced *Leucones*.

The canal system, as thus elucidated, is taken as the basis of the modified classification, which runs thus:—

| | | |
|---|---|---|
| Class CALCAREA. | Order 1. *Homocœla.* | Family 1. *Asconidæ.* |
| | „ 2. *Heterocœla.* | „ 2. *Syconidæ.* |
| | | „ 3. *Leuconidæ.* |
| | | „ 4. *Teichonidæ.* |

(The last family is Carter's, whose reasons for establishing it are adopted.) The genera of the class are entirely reconsidered on the basis of allowing to all the elements of the organization a share in the systematic distinction, and the law of priority in the nomenclature, set aside by Häckel, is reasserted. The genera, as revised, are—

Fam. *Asconidæ: Leucosolenia*, provisionally adopted as the only genus.

Fam. *Syconidæ: Sycon, Grantia, Ute, Heteropegma* n. gen., *Amphoriscus, Anamixilla* n. gen. The chief distinctions employed are the articulation or non-articulation of the tubar skeleton, the mutual independence or not of the tubes, and the form of the spicules. *Heteropegma* differs from *Grantia* in having a cortex composed of spicules of a different size from those of the parenchyma. *Anamixilla* has no special tubar skeleton.

Fam. *Leuconidæ : Leucilla, Leuconia, Leucetta, Pericharax* n. gen. They are based on the form of the ciliated chambers, the arrangement of the spicules, the presence or absence of a cortex, or (*Pericharax*) on the presence of subdermal cavities, such as are found in siliceous sponges.

Fam. *Teichonidæ*: *Teichonella* Carter, and *Eilhardia* n. gen., the latter distinguished by a cup-like form, the oscular and pore-surfaces respectively bearing spicules of a different character.

The general histology is not overlooked. In two species the mesoderm was found to contain some large flattened cells whose protoplasm forms a network upon large spicules, and perhaps contributes to their formation. Ova were found abundantly only in two species. The author's former observations on the spermospores of Calcarea are confirmed; they are undoubtedly of mesodermic origin.

**Australian Monactinellida.**[*]—R. v. Lendenfeld has chosen a rich and comparatively unworked field for systematic work among the sponges, viz. Australia and New Zealand, from which he claims to have specimens of about 500 species at his command. He gives a preliminary account of his classification, with genealogical and structural considerations suggested by the study of this large collection, but appears, unfortunately, not to have attached sufficient importance to the work of previous labourers in this field, for although he refers frequently to the work of Schmidt and F. E. Schulze, whose generalizations are based almost exclusively on the Mediterranean and Atlantic faunas, we find no allusion (as such) to Mr. Carter's very full and carefully constructed system, which embodies the results of the examination of, *inter alia*, very large Australian collections, such as his eminent German colleagues have probably never had access to. Von Lendenfeld derives the *Monactinellida* from the Horny sponges; the two fundamental families of his system are obtained by the subdivision of the older family *Chalinidæ*, viz. into (1) *Chalarchidæ*, characterized by a horny network with scanty and very slender biradiate (acerate) axial spicules. (2) *Chalcœnidæ*, by a horny network with dense masses of large biradiates. From (2) he derives, on one side, (3) *Renieridæ*, containing biradiate spicules, but devoid of perceptible horny substance, and on the other, (4) *Echispidæ*, distinguished by spined spicules projecting from the horny fibre from between them (co-extensive with *Ectyonida* Carter). (5) *Chlathridæ*, with horny network, containing acuate spicules (almost co-extensive with *Axinellida* Carter). From (5) is derived, (6) *Suberitidæ*, with uni-radiates, and without horny substance.

He denies to the flesh-spicules any share in the demarcation of the large groups, but reserves them for generic distinctions; hence Schmidt's and Vosmaer's family *Desmacidinidæ* does not appear. These spicules he regards as of common origin, but as quite distinct from the skeletal spicules. He has, however, been induced to lay less weight on them from having found them in sponges otherwise very distinct from each other—a fact probably due (as his discovery of them in a *Hircinia* shows) to their occurrence as *foreign* bodies in some of the sponges in question.

The skeleton spicules commence with a biradiate form, and proceed by reduction of a ray to the formation of (i.) acuates, and (ii.)

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[*] Zool. Anzeig., vii. (1884) pp. 201–6.

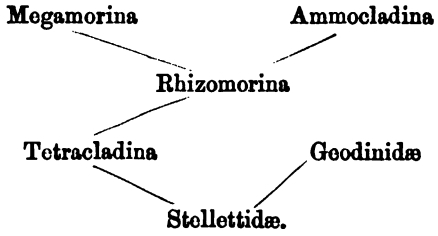
spinulates and spined acuates. The *Myxospongiæ* are regarded as the ancestors of allies of the *Spongiidæ* (s. str.), which have given rise to the *Aplysinidæ* and *Hirciniidæ*. Throughout the Monactinellid series there is a tendency to form flesh-spicules, which are divisible into (1) *Monactinellid*, e. g. anchorates, &c., and (2) *Polyactinellid*, as stellates. They remain insignificant when a fibrous skeleton was already in existence, but where this is wanting they assume its functions and form continuous skeletons.

The boldness of attempting to construct a fresh classification of sponges, and to describe 500 Australasian species when separated by some thousands of miles from the only sound basis for systematic work in this group—viz. collections of authentic types of previous writers—seems scarcely justified by this sample of the results, and must, it is to be feared, lead to the further complication rather than the elucidation of this difficult subject.

**Japanese Lithistidæ.**[*]—L. Döderlein describes some new Lithistid sponges from Enoshima:—*Seliscothon chonelleides*, *Discodermia japonica*, *D. calyx*, and *D. vermicularis*. In the description of these latter he has avoided the use of the expressions individual and colony, but it has been difficult not to use them, for while *D. japonica* has in its simplest condition the form of an individual, it may by budding give rise to other individuals, and to the whole mass the word colony might be properly applied. *D. calyx* has not a single large osculum, but a number of smaller ones, so that here the limits of individuality are at once passed, and *D. vermicularis* has the oscula appearing quite independently of the division, so that the buds that are formed have no individuality. This last, indeed, is neither a simple sponge nor a sponge-colony, but rather a branched sponge.

After an account of the siliceous spicules and of the sarcode, the author refers to the difficulty raised by the fact that, while some of his sponges contained very few embryonic corpuscles, others had a great many; this is to be explained by the periods of vegetation, to which these sponges are subject, and from which is due the maximal and minimal conditions of their growth; they do not live in such deep water as to be free from the influence of the surrounding medium.

After briefly noting the characters of the now twelve known species of this genus, and discussing various points in their physiology, the author passes to the affinities of the Lithistidæ, of which he gives the accompanying phylogenetic table.



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[*] Zeitschr. f. Wiss. Zool., xl. (1884) pp. 62–104 (3 pls.).

The author recommends the study of the form and development of the embryonic parts of the skeleton as affording the best criterion of the correctness or want of correctness of the alliances here suggested.

**Fossil Sponges in the British Museum.***—This fine work from the pen of Dr. G. J. Hinde, a pupil of Prof. Zittel, the great leader in the modern development of the palæontology of sponges, is a fitting tribute to the excellence of the principles of classification which have been laid down by the distinguished professor. Its classification is based essentially on the principle of the employment of the minute structure of the skeleton for its fundamental distinctions. While the adoption (in the Introduction) of the older, Häckelian, grouping of the tissues of living sponges into syncytium (ectoderm and mesoderm of Schulze) and ciliated cells (entoderm of Schulze) is not a happy feature, yet, on his own ground, Dr. Hinde does good service in his careful account of the mineralogical characters of fossil sponges. He upholds the ready replacement of organic silica by calcite. Diagnoses are given of the British species and the new foreign ones; references are given in the case of the remaining described species from foreign horizons; the rich collections of William Smith, Toulmin Smith, Mantell, and Bowerbank render the British part of the collection particularly interesting, and the work may be regarded as a manual of British fossil spongology.

The new genera are 27 in number; of these, *Climacospongia*, *Lasiocladia*, and *Acanthorhaphis* are siliceous Monactinellids; the first strongly resembles *Reniera* in the recent series. *Acanthorhaphis* is perhaps related to the recent *Metschnikowia* of the Caspian Sea. The Lithistidæ, as might have been anticipated, contribute largely to the long list of new types, viz. 10 genera. Of these, the Megamorina are represented by *Placonella*, *Holodictyon*, *Pachypoterion*, *Nematinion*, chiefly distinguished by general form or by points in the arrangement of the internal "canals." To the Tetracladine group of Lithistids Dr. Hinde adds no less than six new types, viz. *Bolospongia*, *Kalpinella*, *Thamnospongia*, *Pholidocladia*, *Phymaplectia*, *Rhopalospongia*; in the last alone does any considerable divergence from the normal character of Tetracladinæ appear in the spiculation, viz. a part of it inclines towards the Rhizomorine type. It is noteworthy as illustrating the advance made by the new system of classification, that a close resemblance is to be traced between the external form of some of these genera and that of genera belonging to quite different groups.

Considering its wider range in time and its greater comprehensiveness, the order Hexactinellida is not so richly represented by new types in this collection as the Lithistidæ. Among the forms with a continuous skeleton (Dictyonina), the Euretidæ contribute two such types, viz. *Strephinia*, which forms irregular or cup-shaped expansions—a habit unusual in the recent members of this family, and *Sestrodictyon*. Ventriculitidæ are represented by a new form, *Sestro-*

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* 'Catalogue of the Fossil Sponges, in the Geological Department, &c., with descriptions of new and little known species.' 4to, London, 1883, 248 pp. (38 pls.).

*cladia*, which is remarkable for its dendroid growth; the branches are hollow. Of the Staurodermidæ of the collection the new forms are *Placotrema* (allied to *Porospongia*), *Cnididerma* (distinguished by having the level dermal surface divided up regularly into squares by the arrangement of its spicules), and *Plectoderma*, differing slightly from *Dictyophyton*, but of which the form is unknown. The Callodictyonidæ have *Porochonia*, based on an old species of *Ventriculites* provided with a delicate surface-tissue besides the usual dermal layer, and *Sclerokalia*, a nest-shaped sponge, with vertical rows of apertures on the inner surface, and shallow canals leading from them. No new Lyssacine Hexactinellid genera are described.

The Calcarea, as defined by Dr. Hinde, are very numerous, owing to the inclusion by him of the *Pharetrones* (distinguished by the possession of a fibrous skeleton) in the group, in which course he follows Zittel and the more recent views of Steinmann and Dunikowski; this step is in partial opposition to Carter and Sollas, who regard some, at any rate, of its members as siliceous. Unlike Dunikowski, who places them under the Leuconidæ, he regards them as constituting a distinct family; he relies largely on the character of the fibre and the methods of arrangement of the spicules in it, for his definition of genera. Few species are described as new. The new genus *Tremacystia* unites a number of already known species, distinguished by a metameric segmentation of the sponge. *Inobolia* is distinguished by its form and the absence of canals. *Trachysinia* has a cylindrical form and may be compound; it is based on three new Jurassic species. *Diaplectia* has the growth of *Pharetrospongia*, but contains tri- and quadriradiate spicules. *Raphidonema* has elongate triradiate spicules like those of *Corynella*. Among the Calcarea, but as *incertæ sedis*, is introduced *Bactronella* n. g., from the Upper Jura; it resembles the recent Leuconidæ, but the spicules are spinous. No Horny sponges find mention.

Tables and lists are given showing the known distribution in time of all the species, from which it appears that the Cretaceous beds contribute to the collection by far the greatest number, viz. the large total of 250 species, of which 103 are Lithistidæ, 85 Hexactinellida, and 46 Calcarea (including *Pharetrones*); the total number of species enumerated is 399. A bibliography is given.

**Vosmaer's Manual of the Sponges.***—G. C. J. Vosmaer completes the review of the literature of sponges commenced in the first instalment of this work.† He devotes seven pages to an account (A) of the best methods of investigation, under the heads (1) *Investigation of the soft parts.*—Killing and preserving, staining, preparation and preservation of sections, decalcification and desilicification. (2) *Investigation of the skeleton.*—Skeleton of the Calcareous Sponges, of the true Horny Sponges, of the Siliceous Sponges. (B) Preservation for collections. (C) Rearing larvæ under the Microscope. For hardening, absolute alcohol, picro-chloric and osmic acids, and corrosive sublimate;

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* 'Dr. H. G. Bronn's Klassen und Ordnungen des Thierreichs. Band ix. Porifera.' Lief. 3–5, 1884, pp. 65–144 (10 pls.). See this Journal, ii. (1882) p. 797.

† See this Journal, i. (1881) p. 611.

for staining, hæmatoxylin, picrocarmine, iodine, chloride of gold, and nitrate of silver are respectively recommended. Under the heading *Morphology* is given a general sketch of the range of shape, size, colour, consistency, and character of the surface in the group. Under *Anatomy* is given an account of the different parts of the canal system of sponges, and their chief modifications. The four types under which the leading modifications of this system are arranged by the author in a previous work are adopted here also.

## Protozoa.

**Nucleus and Nuclear Division in Protozoa.***—A. Gruber passes in review the different groups of the Protozoa; commencing with the Rhizopoda, he points out that, though their nuclei differ considerably, they are all referable to the type of the so-called vesicular nucleus. There is a more or less distinct nuclear membrane, and a clear and apparently homogeneous nuclear substance in which are deposited one or more nuclear corpuscles. Such nuclei are to be found in the lowest myxomycetoid plasmodia, and Bütschli is probably right in regarding this form of nucleus as the primitive one; previous to this, however, there was, in all probability, a stage in which small granules of nuclear substance were scattered through the whole of the protoplasm, and these were only later collected into a proper nucleus. As a fact, there are organisms which exhibit such characters; as, for example, some of the forms described by Maupas, the very low *Trichosphærium sieboldi* (*Pachymyxa hystrix*), and, probably, the *Pleurophrys gennensis* discovered by the author. In all these we find small spheres which are strongly coloured by certain reagents scattered through the body. Moreover, as Brandt was the first to show, *Amœba proteus* contains not only a definite nucleus, but also small granules of nuclear substance.

*Amœba verrucosa* is cited as an example of a form which, though it seems to have a very definite vesicular nucleus, is found on examination with higher magnifying powers (e.g. Hartnack Oc. 3, Obj. 12 Imm.) to have its nuclear corpuscles made up of smaller spherules. When stained, these bodies gradually become less distinctly visible; there appear in the substance of the nucleus excessively fine granules, so fine as to have the appearance of a red dust; these would seem to be true chromatin particles, which may become united into fine filaments; they form lines arranged radially around the nucleolus. They are best seen in specimens that have been treated with absolute alcohol or picrocarmine. Although, therefore, there is a nuclear network in *Amœba verrucosa* it is very incomplete, and, as observation has shown, takes no part in the division of the nucleus. Multinucleolar nuclei are derived from the uninucleolar by repeated division of the nucleolus.

The division of the vesicular nucleus is effected by constriction or by cleavage. In the former case, the chromatic substance is first diffused through the whole nucleus; in the latter case the nucleolus divides first, the halves separate from one another, and then the rest of the nucleus is cut through.

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* Zeitschr. f. Wiss. Zool., xl. (1884) pp. 121–53 (2 pls.).

Among the Rhizopoda two other kinds of nuclei are also seen; in one of them we distinguish a nuclear membrane, and substance, within which are scattered, more or less irregularly, particles of chromatic substance. On division these become arranged into filaments, which, at first coiled, become later on arranged parallel to the long axis of the extending nucleus, and so are equally divided on its constriction. The other form is distinguished by the presence of a cortical zone, generally consisting of granules, which lies just beneath the nuclear membrane. Here there is but little nuclear substance and a large central nucleolus. In division, the nucleolus divides first, and the parts separate from one another; the cortical zone is then divided equatorially, and finally the whole nucleus is cut through.

Lastly, the nuclei of some Foraminifera are remarkable for being distinguishable into two halves, one of which is quite filled with chromatic substance, while the other has one or more nucleoli. The mode of their division is as yet unknown.

The Heliozoa are next taken up, and their nucleus found to consist of a nuclear membrane, clear nuclear substance, and a central nucleolus, or there are several nucleoli; or, finally, there is a membrane, a cortical layer, nuclear substance, and central nucleolus. In this last, division always begins; when there are several they unite into two plates, which separate from one another.

In the large nuclei of the intermediate Radiolaria, we find ($\alpha$) vesicular forms, exactly like those of many Rhizopoda and Heliozoa, ($\beta$) nuclei with a cortical layer (as in *Actinophrys*); ($\gamma$) nuclei with a very strong membrane, dark and often granular nuclear substance, in which radiating bands may sometimes be seen; and ($\delta$) nuclei with a plexiform arrangement of the chromatic substance, and nucleoli imbedded in the meshes; the fissive methods of none of these are satisfactorily known.

The small nuclei of the multinucleate Radiolaria are either amœboid and divide by simple constriction, or are quite round or oval when division commences with the radiate arrangement of the chromatic substance.

The nuclei of the Gregarinida have a vesicular structure, and one or more nucleoli; their mode of division is not known. The nuclei of the spores are quite homogeneous and divide by constriction.

The different groups of the Infusoria are discussed separately; in the true Flagellata we find vesicular nuclei, which divide by the regular constriction of all the parts, and the formation of parallel longitudinal lines in the nucleolus. In *Noctiluca* the nucleus forms a granular mass in which nucleoliform corpuscles are distributed; but in *Leptodiscus* the nucleus is formed of a larger, darker, and granular portion together with a smaller and clearer part. Unlike *Rotalia*, the hyaline part here contains the chromatic substance. In *Noctiluca*, as observed by Robin, the nucleus elongates, and the central part becomes longitudinally striated. In the Cilio-flagellata the nucleus is formed on the "massive" type; that is to say, the nuclear membrane incloses a thick mass of nuclear substance, which, in all probability, contains the chromatin in the form of small granules. So far, the nucleus of the Cilio-flagellata resembles that of the next group—the Ciliata.

The description of the nuclei of the Ciliata offers considerable difficulties in consequence of the numerous variations which are to be seen in the structure of even closely allied species. The nuclear substance may be so dissolved in the cell-substance, and the granules may be so fine as to be only distinguishable with the highest powers; or the constituents of the nucleus may be larger, and formed (as in *Oxytricha*) of spherical corpuscles which, before division, unite into a mass. This substance may form bands and plexuses, and sometimes, as in *Benedenia* and *Plagiotoma*, break up into pieces; this leads to the rosette-like nuclei of *Stentor*, or the band-like nuclei of *Vorticella*. It is rare for an Infusorian to have more than one nucleus, but the number of the paranuclei is by no means so constant. The nucleus is generally "massive" and surrounded by a membrane; its substance is very rich in chromatin-granules, which are very variously arranged; the paranuclei are likewise massive, and apparently always granular. On division, the chromatin-granules form filaments which lie parallel to the long axis of the nucleus, and become constricted in the middle.

The nucleus of the Suctoria, the last group of all, is either branched or rounded; there is a thick massive nuclear substance, in which chromatin-granules are often very distinctly visible. On division, the nuclei break up into filaments which undergo constriction.

The author thus sums up the results of this important investigation:—

There are Protozoa in which the nuclear substance may be distributed through the protoplasm of the cell in the form of numerous granules; and these are often so small that after staining they only appear, on examination under high powers, as a precipitate. In others there are nuclear particles of this kind, but they are not only more numerous, but are also larger, and, in fact, more regularly arranged, so that they may be better spoken of as small nuclei; these lead us to the truly multinucleate forms. He thinks it possible that in those Protista which appear to us to be non-nucleate, the nuclear substance is more or less completely dissolved in the cell-substance; and that in the history of race development there was not at first a definite and formed nucleus, but rather fine nuclear granules. In any case, the formation of a true nucleus is intimately associated with the process of reproduction, and, primarily, with regular division.

A most important piece of evidence is afforded by those Protozoa which, after conjugation and division, are for a time filled with small nuclear particles. It would appear that there is a regular distribution of the chromatin in the daughter-individuals.

The nuclei of the Protozoa belong, as a rule, to one of two types: they are either vesicular, as in most Rhizopods, Heliozoa, Sporozoa, and all true Flagellata, as well as in some Radiolaria and Ciliata, or massive as in almost all Ciliata and Suctoria; the paranuclei, which are probably confined to the Ciliata, are also formed on this type. The process of nuclear division consists in the aggregation of the chromatin mass into a form which is capable of exact division by equatorial constriction. This process is best known, and is most clearly seen in the ciliated Infusoria, when the chromatic substance becomes arranged into filaments of equal length, which are broken through in the middle on the division of the nucleus.

Nuclear division in the Protozoa is a much simpler matter than in the Metazoa, where the arrangement of the chromatic substance is much more complicated; there too the mechanism is quite different, for there is not a division of the nucleus *in toto*, but a breaking up of the nuclear substances followed by their separation. At the same time, Gruber is of opinion that among the Metazoa there are to be found nuclei which are formed on the Protozoic type, and in which division is effected in the same mode as in the Protozoa.

**New Infusoria.**[*]—C. S. Dolley describes a Cilio-flagellate Infusorian in Baltimore drinking water apparently constituting an intermediate species or variety between *Peridinium tabulatum* and *P. apiculatum*.

A. C. Stokes describes[†] a new Choano-flagellate, *Codosiga florea*, found on dead and decaying leaflets of *Myriophyllum* from an aquarium.

Miss S. G. Foulke describes[‡] a new *Trachelius* (*T. Leidyi*), the second true species of the genus, the principal difference between it and *T. ovum* being that while the latter is egg-shaped, the new form is globosely convex dorsally, but flattened with a deep indentation ventrally.

**Stentor cæruleus.**[§]—" J. W." claims to have discovered that " the blue *Stentor* not only takes small food-particles through the oral aperture but that it has the means of projecting portions of its protoplasm to serve the purpose of capturing its prey, for the rotifers and *Paramecia* under observation were slowly drawn into the body still surrounded by a transparent envelope and were gradually absorbed. Sometimes two or more rotifers were seen together in the same *Stentor* undergoing absorption. All movements of the prey ceased when caught by the rhizopod-like extension of the *Stentor*."

**Chlorophyll-corpuscles of some Infusoria.**[‖]—By way of supplement to Prof. E. Ray Lankester's paper on a form of chlorophyll-corpuscle present in *Spongilla* and *Hydra viridis*,[¶] Miss J. A. Sallitt describes the chlorophyll-corpuscles in several green forms of infusoria.

In *Paramecium bursaria* the corpuscles are very numerous, and are scattered through the endoplasm of the animal. They are usually spherical and vary in size from ·0025 mm. to ·006 mm. in diameter.

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[*] Johns Hopkins Univ. Circ., iii. (1884) pp. 60–1.
[†] Amer. Mon. Micr. Journ., v. (1884) pp. 43–5 (1 fig.).
[‡] Proc. Acad. Nat. Sci. Philad., 1884, pp. 51–2.
[§] Amer. Mon. Micr. Journ., v. (1884) pp. 50–1.
[‖] Quart. Journ. Micr. Sci., xxiv. (1884) pp. 165–70 (2 pls.).
[¶] See this Journal, ii. (1882) pp. 322–4.

Each consists of two parts, 1st a ball of clear protoplasm; 2nd an investing cup-like layer of chlorophyll-containing protoplasm (to which the author gives the name of chloroplasm) of a bright green colour. Subdivision of the corpuscles into two, three, and four parts was observed to take place. In *Stentor polymorphus*, *Vaginicola grandis*, and *Phacus triqueter*, *P. longicaudis* and *P. glabra* the corpuscles generally resemble those of *Paramecium*. In *Vorticella chlorostigma* no corpuscles are present, but the chlorophyll is apparently diffused through the endoplasm. In *Euglena viridis* the corpuscles are much flattened and are irregular in outline, and in many cases the chlorophyll appears diffused through the endoplasm; but the author does not agree with Saville-Kent in considering this to be the normal state, and the chlorophyll-bodies to be due to its splitting up previous to multiple division.

If the function of the chlorophyll in animals is the same as that ascribed to it in plants by Prof. Pringsheim, the disposition of the chlorophyll in the animal corpuscle is better adapted to shelter the central colourless protoplasm than that of the substance of the cell. So the greater saving of oxidizable material should take place in the corpuscle itself. No trace of starch is to be found in the corpuscles or in the endoplasm.

**Life-history of Clathrulina elegans.***—Sara G. Foulke states that the modes of reproduction of the Heliozoan *Clathrulina elegans* are four in number, by division, by the instantaneous throwing-off of a small mass of sarcode, by the formation and liberation of minute germs, and by the transformation of the body into flagellate monads. The fourth mode is significant in bringing to light a new phase in the life-history of the Heliozoa. The *Clathrulina* in which the phenomena were first observed, withdrew its rays, and divided into four parts, as in the ordinary method; but the sarcode, instead of becoming granular and of a rough surface, grew smoother and more transparent. Then followed a period of quiescence, in this case of five or six hours' duration, although in other instances lasting three days and nights, after which one of the four parts began slowly to emerge from the capsule, a second following a few moments later. While passing through the capsule, these masses of sarcode seemed to be of a thicker consistence than the similar bodies which, in the ordinary method, instantly assume the *Actinophrys* form. After both had passed completely through for nearly a minute they lay quiet, gradually elongating meanwhile. Then a tremor became visible at one end, and a short prolongation of the sarcode appeared waving to and fro. This elongated at the same time into a flagellum, the vibrations becoming more rapid, until, at the same moment, both the liberated monads darted away through the water. They were followed for about ten minutes, when both were lost to sight among a mass of sediment, and the fear of mistaking one of the common monads for them led the observer to abandon the search. Another monad was followed through various movements, and finally seen to attach the top of its flagellum to the glass, and revolve swiftly for a few moments, when instantly the whole body became spherical, rays were shot out, and the transformed monad was in no point, except that of size, to be distinguished from its *Actinophrys*-like cousin. The whole development, from the time when the monad began its free life, occupied two hours and some seconds.

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* Proc. Acad. Nat. Sci. Philad., 1884, pp. 17-9.

This mode of reproduction secures a more widespread distribution of the young than would be possible did they depend on the sluggish *Actinophrys* form. It seems reasonable to suppose that this is a wise provision for the perpetuation of the species should adverse conditions of life arise and also to prevent an undue accumulation of the animals within a circumscribed space.

**Aberrant Sporozoon.***—J. Kunstler describes an aberrant sporozoon [for which he suggests no name. It is a kind of monocystid Gregarine, found in the body-cavity of *Periplaneta americana.* It is at first placed to the exterior of the epithelial cells of the mid-intestine, in front of the insertion of the Malpighian tubules. It grows in the cell, crosses the muscular tissues, and drives before it the peritoneal investment; the sac thus formed becomes stalked. The Gregarine, after further growth, breaks through the peduncle and escapes into the body-cavity. At first it consisted merely of a single cell with a central nucleus; later on it consisted of two similar bodies, so that it appeared like a pair of conjugated monocystids; here, however, there has been no conjugation, for the nucleus was often seen to be elongated and more or less constricted in its middle, as if it were about to divide. Sometimes there are three lobes. The adult exhibits no movement of translation, and only feeble contractions result from the application of acids. The adult has, when encysted, two envelopes; before encystation it becomes transparent, whereas all other forms are opaque.

**Noctilucidæ.**†—F. Ritter v. Stein in Pt. III. of his 'Infusionsthiere,' gives some new interesting facts respecting *Noctiluca miliaris* and other allied forms. This Infusorian is unusually large, sometimes having a diameter of 1 mm.; although spherical in shape a dorsal and ventral surface may be recognized, as Dönitz first pointed out, by the presence of a rod-like structure (*stabplatte*) which lies in the outer membrane; this body has a shovel-like flattened anterior end and lies on the ventral side of the mouth. The tentacle is supported by two skeletal pieces, and is not apparently a sensory organ as has been thought, but assists in bringing food to the mouth. The protoplasm of the body is not uniformly distributed but lies in a mass between the mouth and the *stabplatte* sending out branched protoplasmic filaments which are attached to the outer membrane. Closely allied to *Noctiluca* is the genus *Ptychodiscus* which has, however, a simpler organization. The body is inclosed by two thick-walled shells of parchment-like consistency united along their margin by a more delicate membrane; the dorsal shell is distinguished from the ventral by a more or less sickle-shaped body corresponding to the *stabplatte* of *Noctiluca*; the ventral shell has an anterior notch in which lies the mouth-slit; the protoplasmic contents entirely fill up the space between the two shells; there is no trace of a tentacle present.

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* Comptes Rendus, xcviii. (1884) pp. 633-4.

† 'Organismus der Infusionsthiere,' Abth. iii. Hälfte ii.

Another Infusorian, *Pyrophacus horologium*, belongs to the same family, and like *Ptychodiscus* was found by Stein in the stomach of *Salpa*; the body is inclosed in a shell which has the appearance of being made up of a number of pieces united in a mosaic fashion; in the same way the shell is made up of a dorsal and ventral half united by membrane; the former is distinguished by the presence of a *stabplatte*; in addition to a mouth-opening there is another opening which is analogous to an anus.

*Noctiluca miliaris*, as is well known, has a great share in producing phosphorescence of the sea on our own coast and elsewhere; but in the neighbourhood of Kiel this Infusorian is not to be found and the phosphorescence there is chiefly due to *Ceratium* and *Prorocentrum micans*.

# BOTANY.

## A. GENERAL, including Embryology and Histology of the Phanerogamia.

**Continuity of Protoplasm.***—E. Russow declares his belief that in all plants during their entire life the whole of the protoplasm is continuous. He bases this conclusion on a series of observations carried out on a plan slightly modified from that of Hillhouse. Fresh sections of the plant to be examined are laid in a solution of 0·2 p.c. iodine and 1·64 p.c. potassium iodide, to which is added a mixture of 3/4 sulphuric acid, and a small quantity of the same acid more concentrated. The sections are then repeatedly washed and stained by anilin-blue; before staining they are sometimes laid in picric acid.

Tangential sections of the cortex of many plants treated in this way showed very clearly the strings of protoplasm connecting adjoining cells. The periphery of the cell-contents is wavy on the longitudinal sides, more or less uneven on the transverse sides. The concavities, which are usually rounded, correspond to the pits; and between the corresponding prolongations of two adjacent cells are seen from three to five moniliform threads of protoplasm, usually strongly curved. In each thread are several granules, usually at regular distances. These threads are met with also between the parenchymatous cells of the bast, and between these and the cells of the medullary rays; in the latter case they are extremely delicate. The threads are seen especially well in *Rhamnus*, *Fraxinus*, *Humulus*, and *Gentiana cruciata*; also in the cortex of numerous other woody plants, as *Prunus*, *Quercus*, *Populus*, *Alnus*, *Æsculus*, &c., and in some herbaceous or climbing plants, such as *Lunaria rediviva*, *Lappa*, *Cucurbita*, &c.

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* SB. Dorpat Naturf. Gesell., 1883. See Bot. Centralbl., xvii. (1884) p. 237. Cf. this Journal, iii. (1883) pp. 225, 524, 677, *ante*, p. 76.

It is noteworthy that, in all the plants examined, the conducting cells do not appear to be in connection, by means of protoplasmic threads, either with one another or with adjacent cells, such as the sieve-tubes and bast-parenchyma; but the author believes that the pits are perforated by very fine threads, which are invisible in consequence of being composed of a homogeneous transparent albumen.

Russow maintains that the perforations in the pits of cell-walls are cotemporaneous with the formation of the cell-wall. During the last stages of the division of the nucleus, in which the protoplasmic threads are stretched between the daughter-nuclei, already at a distance from one another, the cell-wall has the form of a perforated plate, the threads remaining unbroken, and forming a connection between the daughter-cells. He finds that in some cases the radial walls of the cambium-cells have a single row of primordial pits; before each division these about double in diameter; the fine perforations of the closing membranes also increase; the connecting threads of protoplasm probably split lengthwise, and cellulose is formed between them. The perforations between the tangential and transverse walls are formed in the same way, as also the sieve-like perforations in the transverse and longitudinal walls of sieve-tubes.

The author finds also a mucilaginous protoplasmic substance in the intercellular spaces of young cortex, which is strongly developed in the motile organ of *Mimosa*; and here again a communication is effected by means of threads between this protoplasm and that of the cells.

**Continuity of Protoplasm.***—Since his previous experiments on this subject, W. Gardiner has been chiefly employed in testing and improving his methods, and in adding to the number of plants in which he has been able to demonstrate the existence of a continuity of the protoplasm between adjacent cells.

In certain endosperm cells, e.g. *Bentinckia Conda-panna*, where the protoplasmic threads traversing the cell-walls are particularly well developed, it is possible to see the threads perfectly clearly by merely cutting sections of the endosperm and mounting them in dilute glycerine.

The method of swelling with chlor-zinc-iod and staining with picric-Hoffmann-blue is in every way perfectly satisfactory, since but little alteration of the structure occurs, and the staining with the blue is limited to the protoplasm. The sulphuric acid method is in the main unsatisfactory, although it is valuable in the case of thin-walled tissue, where violent swelling must be resorted to; and it is also valuable as affording most conclusive evidence of a protoplasmic continuity in those cases where the protoplasmic processes of pits cling to the pit-closing membrane. The author believes, however, that the results obtained can only be rightly interpreted in the light of the results obtained with chlor-zinc-iod. The possibility of seeing the threads depends on their degree of tenuity, and on the thickness of the pit-closing membrane; and in many cases the only evidence of such perforating threads is afforded by the general staining of the membrane. Every transition occurs between clearly defined threads in the substance of the closing membrane, and the mere staining of that structure as a whole.

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* Proc. Royal Soc., xxxvi. (1884) pp. 182–3; also, Arbeit. Bot. Inst. Würzburg, iii. (1884) pp. 52–87 (English). Cf. this Journal, iii. (1883) pp. 225 and 677.

The author has found in all pitted tissues a pit-closing membrane which is made evident by staining thin sections with iodine and mounting in chlor-zinc-iod, and has never seen open pits. The continuity of the protoplasm is always established by means of fine threads arranged in a sieve-structure, and not by means of comparatively large processes which the occurrence of open pits would necessitate.

A continuity of the protoplasm between adjacent cells occurs in *Dionæa muscipula*, and is especially pronounced in the most central layers of parenchymatous cells. The parenchyma-cells of the petioles of certain plants, which are often thick-walled and conspicuously pitted, afford favourable material for investigation. In *Aucuba japonica* and *Prunus lauro-cerasus* distinct threads can be made out crossing the pit-closing membrane. In *Ilex Aquifolium* there is a doubtful striation, and in others examined a mere coloration of the pit-membrane.

The author believes the connection of cells with one another to be a universal phenomenon, and the functions of the filaments to be as follows:—In sieve-tubes and in endosperm-cells they make possible a transference of solid materials; but in ordinary cells their only purpose is to establish a communication of impulses from one part of the plant to another.

By means of the methods described Mr. Gardiner has examined the seeds of about 50 species of palms, as well as those of representatives of the orders Leguminosæ, Rubiaceæ, Myrsineæ, Loganiaceæ, Hydrophyllaceæ, Iridaceæ, Amaryllidaceæ, Dioscoreæ, Melanthaceæ, Liliaceæ, Smilaceæ, and Phytelephasieæ, in all of which he found that the cells of the endosperm are placed in communication with one another by means of delicate threads traversing their walls.

**Living and Dead Protoplasm.***—O. Loew makes a final defence of his views as to the essential difference between living and dead protoplasm, and the aldehydic nature of the former. The facts relied on are mainly the following:—(1) the rise of temperature on the death of the cell; (2) the sudden setting in of an acid reaction; (3) the fact that living protoplasm does not precipitate any pigment, while dead protoplasm does. The author states that the substance described by Reinke under the name of plastin, is an impure albuminoid soluble with difficulty in dilute potassa; and that nuclein is also chiefly composed of an albuminoid combined with phosphoric acid.

**Occurrence of Protoplasm in Intercellular Spaces.†**—G. Berthold notices several instances of the occurrence of this phenomenon:—in the primary cortex of first-year twigs of *Cornus mas*, *Ligustrum vulgare*, and *Staphylea pinnata*; in the small intercellular spaces between the collenchymatous peripheral cells of the leaf-hinge of *Epimedium alpinum* and of the leaf-stalk of *Pittosporum Tobira*; in the primary cortex of *Rhus glabra*, &c. In order to detect this intercellular protoplasm, uninjured pieces of the plant must be laid in alcohol, or must be first hardened in potassium bichromate. One of the best objects is *Ligustrum vulgare*, where the small intercellular spaces of the young leaves of the winter-buds, as well as those between the young medullary cells, may be found to be filled with a protoplasmic substance.

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* Bot. Ztg., xlii. (1884) pp. 113–20, 129–32. Cf. this Journal, i. (1881) p. 906; ii. (1882) pp. 67, 361, 440, 522; iii. (1883) p. 225.

† Ber. Deutsch. Bot. Gesell., ii. (1884) p. 20.

**Division of the Cell-nucleus.***—The following are the main results of a series of experiments on this subject by E. Heuser:—

The only point which distinguishes the material of the nucleus from the surrounding protoplasm is that it consists to a large extent of nuclein. When at rest the substance of the nucleus consists of granules of various sizes imbedded in the nuclear hyaloplasm which has the form of a framework composed of strings. The granules do not all agree in chemical and physical properties. The nuclear hyaloplasm is surrounded by nuclear sap, apparently identical with the cell-sap, and is in continuous connection with the cyto-hyaloplasm through the membrane of the nucleus. The nuclear membrane consists of an extremely fine-meshed net of cyto-hyaloplasm, in which a few microsomes may be imbedded. This network is entered on one side by the delicate threads of cytoplasm, on the other side by the fine strings of the interior of the nucleus.

The nucleoli are larger collections of nuclear hyaloplasm, which serve as reservoirs for the substance of the nucleus, possibly in solution. The substance of the nucleus is divided, even while it still has the form of a ball, transversely into a number of loops. A further segmentation also occurs in the pollen-mother-cells of *Tradescantia*. The loops consist of nuclear substance, which, both in this condition and in that of rest, is surrounded by a sheath of hyaloplasm. These sheaths are still partially connected with one another after the transverse division of the substance of the nucleus, but afterwards only with the nuclear membrane. Immediately after the disappearance of this membrane, the threads of the hyaloplasmatic figure (the spindle-fibres of Strasburger and the achromatic figure of Flemming) arise out of the sheaths of hyaloplasm by the addition of cyto-hyaloplasm.

The elements of the nuclear substance, before splitting longitudinally into the equatorial plate of Strasburger, are not distributed equally on both sides of the equator; there cannot therefore have been up to this time any "double decomposition" of the equatorial plate or bisection of the nucleus. To render possible the formation of two daughter-nuclei of equal size a further complete division of the nuclear substance must therefore take place. This is effected by longitudinal splitting and re-disposition of the elements under the influence of the hyaloplasm, which is applied as "spindle-fibres" to the ends of the separate rays which lie nearest the centre of the equatorial plane. The separate rays behave differently according to their position and surroundings.

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* Bot. Centralbl., xvii. (1884) pp. 27-32, 57-9, 85-95, 117-28, 154-7 (2 pls.).

After the rays of the daughter-plane have bent at their polar ends in the form of a hook, the fibres of hyaloplasm leave the pole, and appear again on the equatorial side of the rudiments of the daughter-nuclei as "connecting threads." While they are developing, the young daughter-nuclei assume the form of a turban, which favours the absorption of nutriment from the polar side by means of the "polar rays." In consequence of this the transformation of the ball of threads into the framework commences from the polar side. The successive processes of formation of the mother-nucleus are repeated in reversed succession after the longitudinal splitting of the rays.

**Apical Cell of Phanerogams.***—P. Korschelt confirms the statement of Dingler that the cone of growth in flowering plants is developed from a single tetrahedral apical cell, by the separation of daughter-cells. This general law is derived from the observation not only of Gymnosperms (*Pinus Abies*, *P. orientalis*, *P. canadensis*, *Taxodium distichum*, and *Ephedra vulgaris*), but also of Angiosperms (*Elodea canadensis*, *Lemna minor*, *Ceratophyllum submersum*, and *Myriophyllum verticillatum*).

**Nettle-fibre.**†—J. Moeller has made a histological examination of the fibres of the common stinging nettle, *Urtica dioica*, with the following results:—

The primary bast-bundles of the stem do not form a connected ring, and its fibres are mostly separated by intermediate parenchyma. The cortical parenchyma is not sclerenchymatous. At the base of the stem the fibres are mostly about 0·12 mm. in diameter; higher up they are thinner; but even at the summit they have a diameter of 0·04 mm. The thinnest fibres of the nettle are therefore as thick as the thickest of hemp. In consequence of their isolation they are seldom polygonal. At the commencement of the time of flowering, the fibres in the upper portion of the stem only are completely thickened; those in the lower part have still large cavities. There are no pore-canals. Fibres were measured ·22 mm. in length; they are very irregular in form. They consist of nearly pure cellulose; their behaviour with cuoxam is characteristic. They swell with extraordinary rapidity from without inwards; a sharply differentiated internal layer resists the action for some minutes; but this is also at length dissolved; and, in addition to a small quantity of the contents of the fibres, a delicate network remains, the primary membranes of the parenchyma-cells which surrounded the fibres.

In the opinion of the writer, the want of secondary bast-bundles, and the difficulty of separating the fibres completely from the surrounding parenchyma, present insuperable difficulties in the way of using the fibres of the nettle for technological purposes; and the same objections apply to *Laportia pustulata*, which has been attempted to be naturalized in Germany from North America.

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* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 472–7 (1 pl.).

† Deutsch. Allg. Polytechn. Ztg., 1883. See Bot. Centralbl., xvii. (1884) p. 58.

**Laticiferous Tissue of Manihot Glaziovii (Cearà Rubber).***—D. H. Scott describes the laticiferous tissue of *Manihot Glaziovii*, and states the result of his observations to be that in *Manihot* the laticiferous tubes are not *cells* as in the members of the order Euphorbiaceæ hitherto investigated, but *vessels*, agreeing in most points of distribution, structure, and development with those of the Cichoriaceæ.

At the same time this high development of the laticiferous system is not inconsistent with the presence of numerous large and well-developed sieve-tubes. Hence the prevalent views as to the mutual substitution of these two classes of organs are, to say the least, of limited application. Dr. Scott considers it probable that even within a comparatively narrow circle of relationship the development of laticiferous tissue has had more than one starting-point, and he is disposed to assume a distinct origin in the order Euphorbiaceæ for the laticiferous cells and for the laticiferous vessels.

**Laticiferous Tissue of Hevea spruceana.**†—D. H. Scott describes the laticiferous tissue in the stem of *Hevea spruceana* to be similar in its general distribution to that in *Manihot*, and though his observations are not yet complete, its structure seems likewise to take the form of laticiferous *vessels* and not *cells*.

**Development of Root-hairs.**‡—E. Mer has made a fresh series of observations on the conditions favourable for the development of root-hairs, and retains his previous opinion, in opposition to the conclusions of Schwarz, that it is promoted by retardation of the growth of the root. If grains of lentil are made to germinate on the surface of water fixed on a float made of cork, the growth of the rootlets is at first slow. They grow either obliquely or horizontally, or even rise towards the surface of the water, and become covered with long hairs. As their length increases they are more governed by geotropism, and grow in a more vertical direction. The hairs with which they are covered then become gradually shorter. The seeds of the pea, oat, and wheat present similar phenomena. The rootlets which spring from the bulb-scales of the onion are generally destitute of hairs, whether developed in water, moist air, or the soil. But, if allowed to grow for a time in moist air, until their growth has become retarded, a tuft of hairs will make its appearance at the extremity of each.

**Symmetry of Adventitious Roots.**§—Adventitious roots may spring either from a node, in connection with a leaf or axillary bud, or from an internode. Nodal adventitious roots are classified by D. Clos as follows:—

1. *Latero-foliar.* From the edge of a leaf, either on one side

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* Quart. Journ. Micr. Sci., xxiv. (1884) pp. 194–204 (1 pl.).

† Ibid., pp. 205–7.

‡ Comptes Rendus, xcviii. (1884) pp. 583–6. Cf. this Journal, *ante*, p. 79.

§ Ibid., xcvii. (1883) pp. 787–8.

(*Sedum album*, *Berberis cretica*) or from both sides (*Aristolochia rotunda*).

2. *Subfoliar.* Either a single one from the point of insertion of the leaf (*Mühlenbeckia complexa*), or several in a whorl (*Houttuynia cordata*).
3. *Substipular.* From the lower surface of the stipule (*Modiola caroliniana*).
4. *Axillo-foliar.* From the axils either of aërial leaves (*Crassula perfossa*) or of underground scale-leaves (*Mahonia Aquifolium*).
5. *Axillo-stipular.* From the axil of stipules (*Urtica dioica*).
6. *Latero-gemmar.* In connection with the axillary bud, either on one side (*Calystegia sepium*) or on both sides (*Spiræa sorbifolia*); sometimes only from one of two opposite buds (*Paronychia capitata*).
7. *Supragemmar.* From immediately above the axillary bud (*Lythrum Salicaria*, *Lysimachia verticillata*).
8. *Subgemmar.* From below each bud (Equisetaceæ, *Menispermum canadense*).

**Penetration of Branches of the Blackberry into the Soil.**[*]—J. Wiesner finds that the winter-buds of species of *Rubus* growing in woods with creeping branches are drawn into the soil by the shortening of the roots which spring from the apex of the shoot. This shortening takes place in the roots of the zone above the growing region, and results from increase of turgidity, in consequence of which the growing part of the root lengthens. On the boundary of these two zones of the root which behave in opposite ways are the root-hairs, which fix the root firmly into the ground by becoming closely attached to particles of soil. In consequence of this, the upper zone of the stem becomes shorter, and the apex and growing region of the root cannot be drawn out or injured. The traction on this lower part resulting from the shortening of the upper part, is, however, weakened by the fact that, under the conditions in which the upper apex of the root becomes shorter, the lower or growing region stretches. The traction caused by the shortening is exerted simply in dragging the apex of the root into the soil. The shoots which root at their apex become also thicker at their upper end, which could only result from a reversal of the stream of water and from a movement of the protoplasm in a direction opposite to the normal one.

**Circumnutation and Twining of Stems.**[†]—J. Baranetzki argues in favour of Schwendener's view that the twining of stems is due to circumnutation and geotropism, rejecting de Vries's theory of the influence of the weight of the terminal bud.

**Vegetable Acids and their effect in producing Turgidity.**[‡]—According to H. de Vries, organic acids are never absent from the growing parts of plants; they are the principal, and frequently the only causes of turgidity. They are not usually free, but most commonly united with bases, forming either neutral or acid salts. By far the most widely distributed of the organic acids is malic; the bases are either organic or inorganic; the latter chiefly potassa and lime; the former comprise various nitrogenous compounds. The proportion of acids present varies greatly; it is dependent on external circumstances, but is usually greatest in the young growing parts, diminishing gradually with the age of the organ. In young organs they are most commonly present in the form of salts of potash, which is, at a later period, replaced by lime. In addition to their function in producing turgidity, these acids also play an important part in being the agents by means of which potash is absorbed through the root.

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[*] SB. K. Akad. Wiss. Wien, lxxxvii. (1883) pp. 7–17.

[†] Mém. Acad. Imp. Sci. St. Petersbourg, xxxi. See Bot. Ztg., xli. (1883) p. 855.

[‡] Bot. Ztg., xli. (1883) pp. 849–54.

**Metastasis and Transformation of Energy in Plants.***—A. Famintzin publishes an elaborate handbook on this subject, founded on the researches of Pfeffer, Detmer, and others. He classifies the subject under four heads, as follows:—(1) Chemical composition of plants; (2) Organic sources of nutriment; (3) Synthesis of organic compounds; and (4) The interchange of material between plants and their environment.

Under the first head the author includes not only the organic but also the inorganic constituents of plants; as also the crystalline deposits and cystoliths. The second treats of germination and nutrition, including that of insectivorous plants; and of parasites, whether containing chlorophyll or not. The theory of fermentation and structure of ferments is also included here; and the phenomena connected with fermentation are again discussed more in detail in the third part. The fourth section treats of the properties of naked protoplasm, the interchange of substance in a cell inclosed in a cell-wall (diosmose), the absorptive powers of roots and leaves, the movements of gases and water, and the transport of protoplasmic substances. The author does not agree with Sachs's view that metastasis is always accompanied by a loss of weight.

**Action of the different Rays of Light on the Elimination of Oxygen.**†—J. Reinke has designed an apparatus for determining this much-disputed question, which he calls a *spectrophore*.

A horizontal bundle of rays passes from the heliostat through a vertical slit into the dark chamber, and then through a telescope objective at a convenient distance to a sufficiently large prism, placed at the least possible deviation from an angle of 60°, producing a sharp objective spectrum on a screen. The screen consists of two vertical level boards, which can be so moved in a slot that their edges can either be brought close together or placed at any distance from one another; any required portion of the spectrum being then allowed to pass through the opening. Immediately behind the screen is a large convex lens on which the rays fall, and are collected into a focus in a small image of from 1 to 2 sq. cm. By this means any required area of the spectrum can be cut off. When the screen is entirely opened, a white image of the sun is obtained in the focus; when the refrangible portion as far as the green is cut off, a red image; and in the same way a green or blue image can be obtained. In order to bring exactly equal areas of the spectrum under observation, a scale is placed exactly before the screen adapted to the dispersion of the prism, and prepared therefore to suit each particular prism; and the screen is then put in position. The prism was made sometimes of flint-glass, sometimes of bisulphide of carbon; and the action of the various rays of light was determined by measuring the number of bubbles of gas given off in a unit of time from a shoot of *Elodea* growing in water containing carbon dioxide.

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* Famintzin, A., 'Metastasis and Transformation of Energy in Plants,' (Russian), 816 pp., St. Petersburg, 1883. See Bot. Centralbl., xvii. (1884) p. 97.

† Bot. Ztg., xlii. (1884) pp. 1-10, 17-29, 33-46, 49-59 (1 pl.).

The result of the experiments is depicted by Reinke in curves; the absolute maximum of evolution of gas was found to be unquestionably between Fraunhofer's lines B and C, and nearer to the former, corresponding to a wave-length of about $\lambda$ 690–680. From this maximum the curve falls sharply towards the line A, somewhat less sharply towards E, and from these more gently towards H. If the absorption-spectrum of living leaves is compared with this curve, it is seen that the maximum of evolution of gas coincides with the absorption-maximum in the red, or with the absorption-band I, while no secondary maxima of evolution correspond to the secondary absorption-maxima II and III. The maximum of evolution of oxygen, and probably also that of decomposition of carbon dioxide, belongs therefore to those rays of the refrangible half of the spectrum which are the most strongly absorbed by chlorophyll.

From these facts Reinke draws the conclusion that the action of chlorophyll on the elimination of oxygen by plants is a chemical one; although the physical action of chlorophyll on which Pringsheim insists is not altogether excluded, since the strong absorption of the refrangible portion of the spectrum may be connected with this physical function.

**Movements caused by Chemical Agents.***—W. Pfeffer has observed that the motions of motile organisms and parts of plants are to a large extent brought about by the exciting action of special chemical substances, which, in very small quantities, exercise an attracting influence. The substance which exercises the most powerful influence in this way is malic acid, an acid very widely distributed through the vegetable kingdom. It is the presence of malic acid in the archegonium of ferns and Selaginellaceæ which attracts the antherozoids into the open channel; while the specific attracting substance for the antherozoids of mosses is cane sugar. The author was unable to detect the attracting substance in the cases of *Marsilia*, the Hepaticæ, and *Chara*. In the Schizomycetes there is no one specific attracting substance; but any good nutrient fluid has this power; they will move towards the substance which supplies them with most nutriment.

The proportion of malic acid in the fluid in which the antherozoids of ferns are swarming required to influence the direction of their movements is very small, viz. from 0·01 to 0·1 per cent., in combination with any base (sodium malate was most commonly used); it is perceptible even when the proportion is so small as 0·001 per cent. Free malic acid has the same effect as an alkaline salt in very dilute solutions; but when more concentrated it has precisely the opposite effect, causing repulsion. A repulsion is effected by a mixture of 0·01 per cent. malic acid and 0·2 per cent. citric acid; or by 5 per cent. neutral sodium malate.

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* Ber. Deutsch. Bot. Gesell., i. (1883) pp. 524–33; also, Unters. aus d. Bot. Inst. Tübingen, i. (1884); 120 pp.

The presence of so small a quantity as ·001 per cent. of cane sugar has a corresponding attractive force on the antherozoids of mosses. The specific attracting medium has not yet been ascertained which causes the collection of antherozoids around oospheres, as in the case of *Fucus*.

*Bacterium Termo* and *Spirillum undula* were powerfully attracted by a 1 per cent. solution of extract of meat or of asparagin; a higher degree of concentration repels the latter.

The author suggests that the familiar bending of organs in the case of carnivorous plants is due to similar causes.

**Direct Observation of the Movement of Water in Plants.***—G. Capus gives the following account of experiments on this subject, chiefly on the dahlia.

By means of a flat razor a tangential section is made in an internode, a few centimetres in length, cutting into the stem nearly to the depth of the vascular bundles; this cut must be slightly concave. On the opposite side of the stem, and at the same height, two notches are made penetrating to the pith, allowing this part of the stem to be raised so as to expose the medullary canal or pith. This is carefully taken out without cutting the primary wood at the bottom; a transparent section is thus obtained in which the vessels may be examined intact.

The Microscope is placed horizontally in front of the section prepared in this way on a cathetometer. The plant may be observed either growing in the open soil or in a pot. On the section is placed a drop of water flattened by a cover-glass fixed to the stem by a drop of Canada balsam, or held simply by capillarity. The section is then placed opposite the light, when the vessels and fibres of the wood are seen to be full of bubbles of air more or less numerous in strings. When the weather is damp, the sky cloudy, and the ground saturated, the plant contains more water, and there are but few bubbles of air. They are in greater numbers and larger when the weather is dry, and the plant directly exposed to the sun. As soon as the sun no longer shines on the plant, the bubbles of air diminish in size in the vessels and finally disappear, absorption from the roots exceeding transpiration. When, on the contrary, transpiration is relatively active, the index indicates the ascending movement of water in the vessels.

**Rheotropism.**†—This term is applied by B. Jönsson to the influence of running water on the direction of growing plants and parts of plants. To this cause he attributes the motion of the plasmodia of the Myxomycetes. If a plasmodium is placed on a piece of blotting-paper which dips into water at one end, it moves towards the source of water, attracted by the current of water caused by the capillarity of the blotting-paper. Plasmodia are therefore positively rheotropic. Spores of *Phycomyces* and *Mucor* sown on blotting-paper and fed by a current of a nutrient fluid, put out hyphæ which grow with the stream, and which are therefore negatively rheotropic. *Botrytis cinerea* is, on the other hand, positively rheotropic. Roots of seedlings of maize and other cereals which hang down into a free current of water grow towards the stream; they are, like other roots, positively rheotropic.

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* Comptes Rendus, xcvii. (1883) pp. 1087–89.

† Ber. Deutsch. Bot. Gesell., i. (1883) pp. 512–21.

**Transpiration.**[*]—A. Leclerc has performed a series of experiments to determine the laws which regulate the amount of transpiration from the surface of leaves. In a perfectly saturated atmosphere he asserts that leaves do not transpire; they may even acquire a not inconsiderable increase in weight. If the figures obtained from experiments are represented in a system of rectangular co-ordinates, the curve of transpiration is found to correspond much more with the psychrometric than with the actinometric curve. The following are the general conclusions arrived at by the author:—

1. Transpiration is independent of light. 2. It falls to zero in an absolutely moist atmosphere. 3. It is a function of the hygrometric condition of the air, and may be expressed with sufficient accuracy by the equation $E = a(F - f) \pm c$; where $a$ is a coefficient varying for each plant, but invariable for plants in the same series of experiments; $f$ the tension of the aqueous vapour existing at the time in the air; $c$ a positive or negative constant. 4. When the transpiration of a plant is more active in the sun than in the shade, this depends (*a*) on the rays of heat, which always accompany the rays of light, and warm the tissues; and (*b*) on the activity of assimilation of the leaves in the light.

The yellowing of leaves is often due to the transpiration being checked. The disease of the vine known as "folletage," is due to the leaves withering and dying in consequence of excessive transpiration.

**Transpiration-current in Woody Plants.**[†]—J. Dufour continues the discussion on this subject, adducing fresh arguments in favour of Sachs's theory of imbibition; the currents also being assisted by filtration from cell to cell, especially through the agency of pitted vessels. Experiments are described carried on for the purpose of proving that the transpiration-current can only take place through the walls of the wood.

To these arguments R. Hartig replies,[‡] maintaining that the passage of water through the wood does not ordinarily take place through the cell-walls, but by filtration from cell to cell; although the former may occur in special circumstances, as, for example, when all the fluid water has been removed from the wood by transpiration.

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[*] Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 231–79.

[†] Dufour, J., 'Ueber den Transpirationsstrom in Holzpflanzen,' 1883. See Bot. Ztg., xli. (1883) p. 843.

[‡] Hartig, R., 'Die Gasdrucktheorie u. die Sachsche Imbibitions-theorie,' Berlin, 1883. See ibid., p. 844.

**Origin and Morphology of Chlorophyll-corpuscles and Allied Bodies.**[*]—F. O. Bower gives a useful summary and discussion of the results of recent researches on this subject, especially those of Schimper, Meyer, and Schmitz which have already been noted here.

Under the heading of "the Trophoplasts" A. Meyer also gives[†] a summary of the results of the recent work on Chlorophyll-corpuscles.

**Spectrum of Chlorophyll.**[‡]—A. Tschirch continues his researches on "pure chlorophyll," the term which he applies to the product obtained by the reduction of chlorophyllan by means of powdered zinc. In the so-called "solid chlorophyll," obtained by evaporating pure chlorophyll in a glass vessel he notices a small displacement of the absorption-bands of the spectrum towards the red as compared with an alcoholic solution; and the same phenomenon is presented by chlorophyll dissolved and hardened in paraffin. In the solid chlorophyll of the leaf there is a much greater displacement in the same direction. This results, in the author's opinion, from the chlorophyll-grain being a mixture of two substances, pure chlorophyll and xanthophyll. A useful synonymy is appended of the terms employed by different writers in describing the various members of the chlorophyll group.

**Portion of the Spectrum that decomposes Carbon Dioxide.**[§]—C. Timirjaseff maintains that a solution of chlorophyll is not, as held by Wiesner and others, decomposed most quickly by the yellow, but by the red rays. The decomposition of carbon dioxide, as well as the transformation of chlorophyll, is caused by one and the same group of rays absorbed by the pigment. The green group of rays is not absorbed at all by weak solutions of chlorophyll.

**Chlorophyll in Cuscuta.**[‖]—The parasitic *Cuscutæ* have hitherto been described as entirely destitute of chlorophyll. F. Temne, however, finds distinct indications of its presence by *C. europæa*. This was established by an evident green tinge, either of the whole protoplasm or of separate granules, especially in the inflorescence; by the spectrum of chlorophyll obtained in an alcoholic extract; and by direct evidence of the evolution of carbonic acid.

**Work performed by Chlorophyll.**[¶]—From a series of experiments, C. Timirjaseff deduces the result that, where there is energetic decomposition of carbon dioxide, 20 per cent., and, under specially favourable circumstances, as much as 40 per cent., of the entire solar energy is utilized by the chlorophyll, the proportion thus used up being very much larger than has been assumed by Pfeffer and Pringsheim.

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[*] Quart. Journ. Micr. Sci., xxiv. (1884) pp. 237–54 (1 pl.).

[†] Biol. Centrabl., iv. (1884) pp. 97–113.

[‡] Ber. Deutsch. Bot. Gesell., i. (1883) pp. 462–71 (1 pl.); and ibid., Generalvers. in Freiburg., xvii.–xxii.

[§] Arbeit. St. Petersb. Naturf. Gesell., xiii. (1883) p. 10 (Russian). See Bot. Centralbl., xvii. (1884) p. 101.

[‖] Ber. Deutsch. Bot. Gesell., i. (1883) pp. 485–6.

[¶] Arbeit. St. Petersb. Naturf. Gesell., xiii. (1883) p. 9 (Russian). See Bot. Centralbl., xvii. (1884) p. 100.

**Sphærocrystals.***—A. Hansen has examined the structure of crystals in a number of plants. Those found in the cells of several species of *Euphorbia* agree in general with the ordinary form, and consist of calcium phosphate; as also do those of *Mesembryanthemum* and of *Marattia cicutæfolia* and *Angiopteris evecta*. Those of *Cocculus laurifolius* and of *Capsella*, on the other hand, do not consist of any phosphate, but are apparently organic in their nature.

The author asserts that sphærocrystals do not grow, either by apposition or in any other way. They appear in the cell-contents in the form of drops, which gradually harden into solid bodies. They are invested by a pellicle; and their striking stratification does not result from their mode of growth, but from a differentiation during hardening.

The conclusions of the author were confirmed by observing the behaviour of artificial sphærocrystals made of calcium phosphate and calcium carbonate.

**Sphærocrystals of Paspalum elegans.**†—According to J. Borodin, if sections of the leaf of *Paspalum elegans* are moistened with alcohol, and the latter allowed to evaporate under the cover-glass, peculiar yellow sphærocrystals make their appearance, which shine brightly in polarized light. They are easily soluble in hot, less easily in cold water, rapidly in dilute hydrochloric acid, and especially in weak potash-lye, colouring it an intense yellow. When carefully warmed, they melt into homogeneous intensely yellow, strongly but not doubly refractive balls, still soluble in water. The substance which affords these sphærocrystals is very peculiarly distributed in the plant. It occurs only in the lamina of the leaves, the leaf-sheaths and stems being quite free from it. It is especially abundant in the apical part of the leaf. The distribution of potassium nitrate is exactly the reverse.

Although these properties resemble to a certain extent those of leucin in the dahlia, yet careful experiments show that the substance which yields these sphærocrystals is not leucin. But under special circumstances leucin is found in the leaf of *Paspalum elegans*.

**Calcium Oxalate in Bark.**‡—From observations made on the deposits of calcium oxalate in the bark of a considerable number of trees, S. Rauner is led to adopt the ordinary view that this substance is an excretory product, and not a reserve food-material. He found that they did not disappear from the bark as the new shoots were put out, but were constantly present at all times of the year.

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* SB. Phys.-Med. Gesell. Würzburg, 1883, pp. 20–2.

† Arbeit. St. Petersb. Naturf. Gesell., xiii. (1883) pp. 47–60 (Russian). See Bot. Centralbl., xvii. (1884) p. 102.

‡ Arbeit. St. Petersb. Naturf. Gesell., xiii. (1883) pp. 24–33 (Russian). See Bot. Centralbl., xvii. (1884) p. 101.

## B. CRYPTOGAMIA.

### Cryptogamia Vascularia.

**Stigmariæ.**[*]—Professor Harker has made the following determination of the species of *Stigmaria* found by E. Wethered in the Durham coal-beds. The microspores strikingly resemble those of *Isoetes*, especially when gently crushed. The triradiate markings of the fossil spores were almost exactly like the flattened three radiating lines which mark the upper hemisphere of the microspores of *Isoetes lacustris*. He suggests for the carboniferous plant the generic title *Isoetoides*.

In the discussion which followed the reading of this paper, Mr. W. Carruthers and Mr. W. Boyd Dawkins did not agree with the author in identifying these spores necessarily with the form allied to *Isoetes*. Neither true woody tissue nor sporangia are to be found in coal, although macrospores and microspores abound. Coal is composed of two principal elements, carbon proper and a fossil resin; the blazing property of coal is due to the latter, which is composed mainly, but not entirely, of fossil spores.

### Muscineæ.

**Cephalozia.**[†]—In addition to the characters hitherto employed for distinguishing the families and genera of Hepaticæ, R. Spruce considers the following as of value:—(1) The origin of the branches, which are either all ventral, as in *Cephalozia*, *Calypogeia*, &c., or all lateral, as in *Lejeunia*, *Radula*, &c. (in *Frullania* and *Scapania* all are exactly axillary; in *Lejeunia* and *Radula* infra-axillary, nearer the outer base of the leaf). (2) The origin of the angles of the perianth, which originate either from the marginal coalescence of nearly flat leaves, as in *Lophocolea*, *Plagiochila*, &c., or from the wedge-shaped leaves, as in *Cephalozia*, *Scapania*, &c. (3) The structure of the wall of the capsule. (4) The number of sexual organs, especially of the male, which is very constant in many genera.

Then follows an exhaustive diagnosis of the genus *Cephalozia*, of its subgenera, and of most of its species. The most important generic characters are:—Prothallium filiform; branches of ventral origin; leaves flat or curved inwards, never reflexed; perigonial leaves always with only a single male organ; female inflorescence capitular, lateral, with its leaves in three rows; perianth free, triangular-wedge-shaped, the third edge always ventral; cap free; wall of capsule with semicircular fibres; elaters bi-spiral.

The genus is divided into eight subgenera, and a large number of species are described. The first two subgenera, each comprising only a single species, are thallose, the rest foliose. Several genera nearly allied to *Cephalozia* are also described, making up the author's tribe Trigonantheæ.

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[*] Abstr. Proc. Geol. Soc. London, March 5, 1884.

[†] Spruce, R., 'On Cephalozia, a genus of Hepaticæ.' Malton, 1882. See Bot. Centralbl., xv. (1883) p. 300.

The author considers the separation of the Jungermannieæ Geocalyceæ as a distinct group to be unsound, each group having one or more "marsupial" (geocalyceal) genera. The passage between aboveground and underground perianths occurs in those genera the perichætium of which is more or less united into a fleshy cup which may swell and form a rooting protuberance; further development downwards leads to a pendent sac. Thus *Acrobolbus* is a direct derivative from those species of *Nardia*, like *N. Breidleri*, the rooting projecting involucre of which is the forerunner of the pendent pocket of *A. Wilsoni*; the vegetative organs of both are similar.

The following are the characteristics of the three proposed primary groups of Hepaticæ:—(1) *Hypocoleæ*, with free involucre; (2) *Epicoleæ*, perianth and involucre coalescent; (3) *Marsupiocoleæ*, with sac-like fructification. The genera of Jungermannieæ can be classed under these three groups, thus:—(1) *Leioscyphus* and *Jungermannia*; (2) *Southbya* and *Nardia*; (3) *Lindigina* and *Acrobolbus*.

## Fungi.

**Lamellæ of the Agaricini.***—H. Heese has paid special attention to the structure of the lamellæ of the Agaricini, with a view of obtaining for them characters for the classification of the genera.

The structure of the trama may be classified under five heads, as follows:—

1. Trama homomorphous, with parallel threads of cells.
2. Trama homomorphous, with curved hyphæ.
3. Trama heteromorphous, elongated; with usually ribbon-shaped cells at the sides, vesicular cells in the middle.
4. Trama heteromorphous; usually with vesicular and ribbon-shaped cells intermixed (*Russula*, *Lactarius*).
5. Trama heteromorphous; elongated cells in the middle, round cells at the side (*Coprinus*).

These different forms run into one another.

When fully developed the hymenium is composed of four kinds of cells: (1) long pointed cells, cystidia; (2) short pointed cells, paraphyses; (3) short cells, rounded at the end, sterile basidia; and (4) cells like the last, but bearing spores, fertile basidia. Of these the last kind are always present; any of the three others may be wanting. Fleshy fungi rarely have paraphyses or cystidia; the latter are found chiefly in small membranous species. The regular occurrence of paraphyses is characteristic of *Coprinus*. The basidia may be classed under three heads: (1) narrow, occurring only with white-spored genera; (2) short; (3) long.

Fungi with homomorphous trama and ribbon-shaped interwoven hyphæ usually have narrow basidia, as in *Cantharellus* and *Clitocybe*. These series are connected on one side with *Mycena* with heteromorphous trama, on the other side with *Tricholoma* with parallel cells. In proportion as heteromorphism increases, a change may be seen from the basidial form of *Mycena*, through *Galera* and *Psathyra*, to *Coprinus*. The third group, with long basidia, can also, with the exception of *Lactarius* and *Russula*, be arranged in a series of relationship, the highest forms of which are *Amanita* and *Volvaria*.

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* Heese, H., 'Die Anatomie der Lamelle, u. ihre Bedeutung für die Systematik der Agaricineen,' 43 pp., Berlin, 1883. See Bot. Centralbl., xvii. (1884) p. 68.

With reference to the formation of sterigmata and the abstriction of spores, Heese dissents from the view that the same basidium may produce spores several times. He adduces several instances of dual sterigmata.

The cystidia may be used for the distinction of species to a much greater extent than the basidia, in relation to their position, size, and form. They may be fusiform, pear-shaped, and pointed at the end, capitulate, or hair-like. The writer is unable to determine their function.

The colour of the spores is characteristic; they should be observed both dry and moist, as they frequently change their form when moistened. The size of the spores has no relation to the size of the fungus, but only to that of the basidia. In the white-spored subgenera, the spores have a tendency to be rounded and shorter; light brown spores are mostly ovoid, dark brown spores ellipsoidal; black spores are always ellipsoidal.

**Formation of Gum in Trees.**[*]—Sir James Paget draws attention to some remarkable investigations made by Dr. W. Beyerinck[†] in connection with the formation of gum in trees. Dr. Beyerinck found that in the peach, apricot, plum, cherry, or other trees bearing stone-fruits, the formation of gum may be caused by inserting a portion of the gum under the edge of a wound through the bark. The observation that heated or long-boiled pieces of gum would not produce this effect, and that wounds made in the bark of the tree did not produce gum unless a portion was first introduced into it, led him to suspect that the formation of gum was due to the presence of bacteria or other living organisms. On microscopical investigation he found that only those pieces of gum containing spores of a highly organized fungus, belonging to the *Ascomycetes*, had the power of conveying the gum-disease or gummosis, and that these spores, inserted by themselves under the bark, produced the same pathological changes as did the pieces of gum. The fungus has been examined by Professor Oudermans, who has ascertained it to be a new species, and has named it *Coryneum Beyerinckii*. Its chief characters consist in the fact that it has a cushion-like stroma, composed of a bright brown parenchyma, on which stand numerous conidia having colourless, unicellular and very slender stems, about as long as themselves. The conidia are small, cask-shaped, about one-third of a millimetre in length, and usually divided by slightly constricting septa into four cells, of which the two terminal are longer than the two middle ones. From these cells germinal filaments may proceed, from which are developed brown, thick-walled, and many-celled mycelia. The first symptom of the gum-disease is the development of a beautiful red colour around the wound due to the formation of a red pigment in one or more of the layers of the cells of the bark. Dr. Beyerinck believes that the fungus produces a fluid of the nature of a ferment, which penetrates the adjacent structures, since the disease extends beyond the parts in which any trace of the fungus can be detected. This ferment he believes to act on the cell-walls, starch-granules, and other constituents of the cells, transforming them into gum, and even changing into gum the *Coryneum* itself. The influence of this fluid is also exerted in the cambium, causing the formation of morbid parenchyma, the cells being cubical or polyhedral, thin-walled and rich in protoplasm, which is in its turn transformed into gum. It is further stated that "a similar disease produces gum arabic, gum tragacanth, and probably many resins and gum resins." Gum tragacanth is known to be produced by the pith as well as the bark of the stem, and to ooze out from the pith when the stem is cut; and if it be indeed due to a disease it would seem as if the disease infects the whole plant. Gum, moreover, may be found in the uninjured husk of the almond, and it seems at first sight more probable that the irritation caused by a fungoid parasite should cause a greater flow of the natural product, just as the irritation caused by an insect causes the development of galls.

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[*] Bull. Torrey Bot. Club, xi. (1884) pp. 33–4 from 'Medical Times.'

[†] Arch. Néerl. Sci. Exact. et Nat., xix. (1884) pp. 43–102 (2 pls.).

**Attraction of Insects by Phallus and Coprinus.***—E. Ráthay and B. Haas have examined the structure of the fructification of *Phallus impudicus*, with a view to determine the peculiarities in its construction which attract flies and other insects to it. This is effected partly by the odour and partly by the taste. They find the fluid which results from the deliquescence of the gleba to contain abundance of sugar; and visiting this they observed as many as fourteen species of insect, most of which also visit the nectar of flowers or feed on honeydew.

The same phenomenon is exhibited by a number of other species of Phalloideæ; and the explanation suggested is that the insects are useful to the fungi in disseminating the spores, which are set free by the deliquescence of the gleba.

The pileus of species of *Coprinus* and of some other species of Agaricini also exude sugar.

With regard to the exact chemical nature of the substance formed, the authors state that it consists in all these cases, in addition to dextrose, of another sugar which also belongs to the same class, and is probably trehalose. In *Phallus impudicus* there are no less than three substances which reduce alkaline solution of copper, viz. dextrose, levulose, and a substance intermediate between dextrose and gum. In *Coprinus deliquescens* the only one of these substances present is dextrose.

**Development of Ascomycetes.**†—After some further details of the points in the development of the Ascomycetes already alluded to, E. Eidam describes two other remarkable species.

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* SB. K. Akad. Wiss. Wien, lxxxvii. (1883) pp. 18–44.

† Cohn's Beitr. Biol. Pflanzen, iii. (1883) pp. 377–433 (5 pls.). Cf. this Journal, *ante*, p. 94.

*Helicosporangium parasiticum* has been found especially on carrots. The mycelium branches copiously, the ends of the branches coiling like a watch-spring, a second spiral often springing from the stalk of the first, and becoming closely united with it in growth. The spirals become septated, and a central cell is separated, which increases considerably in size, becomes brownish red and densely filled with protoplasm, while the cortical cells are nearly empty, the central cell only germinating. The fungus produces also conidia.

*Papulispora aspergilliformis* is found on all kinds of decaying substances, such as stems, seeds, fruits, tubers, &c., forming a delicate white coating, which is soon covered with the brownish red clusters of spores. The mode of reproduction is by conidia resembling those of *Aspergillus*; but the fungus also produces very peculiar reproductive bodies, which are called bulbils by the author. It also produces chlamydospores.

**Fungi Parasitic on Forest-trees.***—In continuation of previous investigations, E. Rostrup gives the following account of the parasitic fungi most destructive to forest-trees in Denmark.

*Melampsora salicina.* The author confirms the statement of Nielsen that the species of *Melampsora* found upon willows belong to the heterœcious Uredineæ, and that *Cæoma Ribesei* and *Euonymi* are their æcidial forms, while *C. Mercurialis* is the æcidial form of *M. Tremulæ.*

*Peridermium Pini corticola*, the vesicular æcidial form of *Coleosporium Senecionis*, has been of late years very destructive to *Pinus Strobus* in Denmark, completely destroying plantations from five to twenty years old. Since the æcidial form cannot propagate itself from tree to tree, while *Coleosporium* will maintain itself from year to year, the complete destruction of *Senecio sylvaticus* would be an effective way of eradicating the pest.

*Cæoma pinitorquum* often makes its appearance in large quantities on young plantations of various species of pine on the heaths of Jutland. *C. Laricis* has also found its way into Denmark, attacking the European and American larches since 1881.

*Agaricus melleus* sometimes destroys as much as 25 per cent. of the young pines in the Jutland plantations, rhizomorphs more than 11 feet long having been dug out of the ground; they attack and completely destroy felled trunks of oak or ash lying on the ground. Rostrup gives a list of twenty-four species of tree which this destructive parasite attacks.

In older plantations of conifers, still greater injury results from the attacks of *Trametes radiciperda*, which also occasionally seizes upon young trees.

*Polyporus fomentarius* is a true parasite, the mycelium of which permeates the entire duramen of beech-trees, attacking them when quite healthy. *P. betulinus* is also injurious to birch-trees; and *P. nigricans* is found in a half-fossil condition on the trunks of *Betula alba* buried in turf-mosses.

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* Müller's Tidsskr. for Skovbrug., vi. (1883) pp. 199-300 (17 woodcuts). See Bot. Centralbl., xv. (1883) p. 147.

*Thelephora laciniata* is injurious to conifers from one to two years old, attacking especially *Pinus montana* and *Picea excelsa*.

*Corticium comedens* often attacks and kills young oaks and alders.

Of the Gymnoasci which form the "witch-brooms," *Exoascus* is especially described on various species of *Prunus*, *E. Carpini* on the hornbeam, and *Taphrina betulina* n. sp. on the birch. The colourless branched mycelium of the last species penetrates the branches and leaves, forming on the under side of the latter a mealy coating composed of the asci (about 45–55 μ long and 20 μ broad; in which are numerous ovate or elongated spores, about 5–7 μ long and 3–4 μ broad.

*Peziza Willkommi* has attacked a large number of young trees in a larch plantation. A few inches above the ground the bark assumes a red colour, and is covered with numerous whitish warts, the spermogonia of this fungus, containing a quantity of extremely small elliptical and slightly curved spermatia. The apothecia are developed somewhat later, a little higher on the stem. Beneath the coating of spermogonia the cambium-layer is entirely destroyed.

*Lophodermium pinastri*, which is exceedingly destructive to the Danish pine-woods, is treated at length, and is shown to be the cause of the disease known in Denmark as "Schütte." The leaves of trees from one to two years old are permeated by the colourless, branched and unseptated mycelium, causing them to turn brown. The spermogonia appear at the same time in great numbers on the cotyledons and primary leaves of the main stem, as black elongated, or slightly curved lines. They are filled with numerous rod-shaped spermatia, 6–8 μ long and about 1 μ broad. They always precede the formation of perithecia. It is most destructive to *Pinus austriaca*.

Another species, *Lophodermium brachysporum* n. sp., attacks *Pinus Strobus*. The perithecia are smaller than in the last species, and are placed in a single row on the under side of the leaves, often while they are still green. The asci are 100 μ long and 20 μ broad; the spores 20–25 μ long and 4 μ broad, and are surrounded by a gelatinous envelope. On *P. austriaca* is also found another species, *L. gilvum* n. sp., with very small oval pale-yellow perithecia, inclosing paraphyses 80–85 μ long, and asci 75–80 μ long and 10–12 μ broad, each of which contains eight long filiform spores.

*Hypoderma sulcigenum* n. sp. is an ascomycete, producing on *Pinus sylvestris* and *montana* a similar appearance to that of *Lophodermium pinastri*. It appears locally on the leaves, producing brown spots and streaks; the perithecia are black and linear, from 1–5 lines long, and open by a longitudinal crevice. They inclose filiform paraphyses and club-shaped asci 75–85 μ long and 12 μ broad, each containing four club-shaped spores, 30–40 μ long and 4 μ broad, at the thickest part, inclosed in a gelatinous envelope which is coloured a beautiful bright green by iodine. The mycelium, which permeates the leaves, is colourless, much branched, and unseptated. It is probably identical with Link's *Hypodermium sulcigenum*.

*Hysterographium Fraxini* is destructive to ash-trees from 6 to 10 feet high. Fawn-coloured depressed spots appear on the stem, consisting of a colourless branched mycelium which penetrates the bast and cambium to the outermost layer of wood; on this mycelium are the pycnidia, which burst through the bark, and contain the colourless stylospores, 32–38 μ long, and about 11 μ broad. Shortly afterwards the perithecia appear on the same spots.

*Nectria ditissima* causes injury in oak and beech plantations from fifteen to twenty years old, and on apple-trees in gardens. *Phytophthora Fagi* has made its appearance on beech-trees. *Fusicladium ramulorum* has appeared on the young shoots of several species of willow and poplar, turning the leaves brown or black. The black spots on the leaves and branches are covered with an olive-green coating, which forms dendriform fissures, resembling those of *F. dendriticum*. The conidia are bright greenish yellow, bilocular, and of a peculiar form like that of the sole of a shoe, 18–20 μ long and 6–7 μ broad.

**Puccinia graminis on Mahonia Aquifolium.**[*]—C. B. Plowright has determined that an æcidium found on the berries of *Mahonia Aquifolium* gives rise, when the spores are sown on the leaves of wheat, to *Puccinia graminis*. This will account for the frequency of the wheat mildew in districts where the berberry is unknown; the *Mahonia* being widely cultivated in gardens and shrubberies, and as a cover for game. The same writer[†] has also determined the dock æcidium, which is common on *Rumex Hydrolapathum*, *obtusifolius*, *crispus*, and *conglomeratus*, to be the æcidiospore of *Puccinia Phragmitis*. On the other hand, the æcidium of *Rumex acetosa* is not connected with either *Puccinia Phragmitis* or *magnusiana*.

**Polystigma rubrum.**[‡]—W. B. Grove gives some account of *Polystigma rubrum*, Pers., based upon the recent investigations of A. B. Frank[§] and C. Eisch[‖]. It usually makes its appearance shortly before midsummer on the leaves of *Prunus domestica*, *P. spinosa*, and *P. insititia*. Its whole life-history is probably now known as Mr. Grove shows. The only point left in doubt is the mode by which the ascospores are conveyed from the ground to the young plum leaves.

**New Synchytrium.**[¶]—Under the name *Synchytrium pilificum*, F. Thomas describes a new species parasitic on *Potentilla Tormentilla*. It produces tufts of hairs on the stems, flower-stalks, leaves, sepals, and petals of the host, most frequently on the upper side of the leaves. They proceed from a wart, 0·36–0·39 mm. in diameter, and rising 0·11–0·27 mm. above the surface of the leaf; their number being usually between 20 and 35. The base of the wart is of a yellowish green or reddish violet colour. They do not seem to be very injurious, as, even when the petals are attacked, the flowers produce normal fruits. In the centre of each wart is a large brown cell, the resting-spore of the *Synchytrium*, inclosed in and entirely filling up the nutrient cell. It is of a shortly elliptical or spheroidal shape, from 0·14–0·126 mm. in its largest diameter, and inclosed in a double wall. These develope and form swarm-spores in the spring in the same way as other species of *Synchytrium*; but further details are wanted. The trichomes of the æcidium are unicellular and thin-walled, and when old coil hygroscopically.

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[*] Proc. Roy. Soc., xxxvi. (1883) pp. 1–3.

[†] Ibid., pp. 47–50.

[‡] Quart. Journ. Micr. Sci., xxiv. (1884) pp. 328–34.

[§] See this Journal, iii. (1883) p. 685.

[‖] Ibid., p. 247.

[¶] Ber. Deutsch. Bot. Gesell., i. (1883) pp. 494–8.

**Pathogenous Mucorini, and the Mycosis of Rabbits produced by them.***—L. Lichtheim has found two species of Mucorini which cause pathogenous phenomena when introduced into the blood of rabbits. One of these made its appearance normally in white bread when placed in the breeding oven, in the form of a dense white silky flock, soon entirely covered by *Aspergillus*. This was propagated separately on strips of nutrient gelatine spread on glass plates. If the temperature of the chamber was not too high, the spores swelled up on the third day and put out a germinating filament on one side; on the third or fourth day these had grown into a copiously branched unseptated mycelium, which gradually completely overspread the nutrient substance. On the third or fourth day aerial branches appeared, the formation of sporangia commencing very soon at their apex, the other portion turning back after the manner of the stolons of *Mucor stolonifer*. The sporangiophores are usually simple, rarely dichotomously branched; opposite to them rhizoids are formed; the sporangia are black, smooth, and globular. The spores are nearly globular, strongly refractive, and inclosed in a single membrane.

The second species was less common, and is distinguished from all known Mucorini by its very small size. It appeared in a gelatine-culture of infusion of bread, and was propagated in the same way as the first. The mycelium is loose and crinkled; the sporangia extremely small and colourless. It spread very slowly over the nutrient substance, forming only distant streaks. From the delicate unseptated mycelium there rise long slender sporangiophores, on which are placed six or eight very small almost transparent sporangia. The sporangia are seated in a small cup-shaped swelling of the sporangiophore, and have somewhat the form of a pear. The spores are nearly globular, and strongly refractive.

In neither species were zygospores observed. Professor Cohn has named and described them as follows:—

*Mucor rhizopodoformis.*—Mycelium at first snow-white; filaments colourless, unseptated; brownish branches of the mycelium ascend as stolons, then bend, and sink down again on to the substratum; at the points of contact the mycelium puts out downwards short-branched brownish rhizoids, sporangiophores upwards. Sporangiophores simple, collected into tufts of two or more, unbranched, 120–125 $\mu$ high. Sporangia globular, seated on the apex of the sporangiophore, black when ripe, with smooth opaque membrane, which is soluble in water, without leaving behind any granular deposit; diameter 66 $\mu$. Column brownish after the absorption of the wall of the sporangium, wall swollen at the summit; sporangiophore separated from the column by a flat broad apophysis. Spores colourless, mostly globular, smooth, very minute, 5–6 μ in diameter. Several characters, besides its pathogenous properties, distinguish this species from *M. stolonifer*.

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* Zeitschr. f. Klin. Medicin, vii. (1883) (3 pls.). See Bot. Centralbl., xvii. (1884) p. 138.

*Mucor corymbifer.*—Mycelium snow-white, afterwards light grey; filaments often very stout, 15 μ in diameter, unseptated, dichotomously branched; membrane and protoplasm colourless. Sporangiophores not erect, branched in an umbellate manner, bearing at the apex one or more (up to twelve) sporangia with longer or shorter stalks; other smaller sporangia being arranged in a raceme below the terminal umbel. Sporangia colourless even when ripe, pear-shaped, rounded at the end, passing gradually into the sporangiophore, varying greatly in size, the largest 70 μ, the next in the umbel 45-60 μ, and the smallest detached sporangia 10–20 μ in diameter; membrane colourless, transparent, quite smooth; the colourless mass of spores seen through the wall of the ripe sporangium; the column appears only after the absorption of the wall of the sporangium and dispersion of the spores. Spores colourless, minute, elliptical, 3 μ long by 2 μ broad. This species is also distinguished by several very striking characters independent of its pathogenous properties.

If the spores of these two species of *Mucor* are sown in any quantity in the blood of rabbits, a severe disease is caused, which is always fatal. The two species act in very nearly the same way, but the *Mucor* mycosis differs considerably from that of *Aspergillus*. The localization is also different; the *Mucor* entered chiefly the kidneys and the lymphatic apparatus of the intestinal canal, seldom the medulla of the bones, and only very rarely the liver; never the transverse muscles. In the brain neither *Mucor* nor *Aspergillus* was found.

**Micrococci of Pneumonia.***—C. Friedländer has examined the micrococci contained in the alveolar exudation, and in the fluid of the lymph passages of the lungs, in cases of acute genuine pneumonia. Their presence was subsequently determined in the pneumonial fluid taken from the living patient. They were found in the greatest numbers in the pleuritic and pericardial exudations, the turbidity of these fluids often arising from enormous quantities of the micrococci. All or the greater number of these micrococci are surrounded by a more or less broad layer resembling an envelope or capsule, coloured light blue or red by gentian-violet or fuchsin respectively, and usually sharply defined externally. Sometimes each micrococcus is surrounded by an envelope of this kind of the same shape; sometimes two or three are inclosed in the same envelope; but the micrococci of pneumonia are never collected into zooglœa colonies. These envelopes are soluble in water and dilute alkalies, but insoluble in acids, and may therefore consist essentially of mucin or some similar substance.

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* Fortschr. d. Medicin, i. (1883) pp. 715–33 (1 pl.). See Bot. Centralbl., xvii. (1884) p. 50.

The micrococci are best detected by placing the cover-glass with the dried-up fluid, coloured by aniline-water and gentian-violet solution, in a watch-glass with alcohol for half a minute, when the matrix rapidly loses its colour, the envelopes and micrococci much more slowly. The preparation may then be placed in a watch-glass with distilled water, examined in water, and afterwards preserved in Canada balsam or dammar lac. The envelopes are also coloured by eosin, especially by a weak solution acting for twenty-four hours; osmic acid differentiates them sharply, but without blackening them. These envelopes appear to be a highly characteristic peculiarity of the micrococci of pneumonia, never failing in acute genuine cases. They probably belong to the acme of that disease, not being found after the sixth day.

If developed by Koch's process on serum of blood and afterwards on gelatine, with addition of infusion of flesh, peptone, and sodium chloride, the micrococci have on serum of blood the form of a greyish pellicle on the surface, and an opaque cylinder in the interior of the serum. The cultures on gelatine were especially characteristic, and were propagated for eight generations. They resembled a nail with hemispherical head, and consisted of densely crowded micrococci, usually of elliptical form, but with no envelope. They were also cultivated on potato.

Experiments were also made in inoculating the pneumonia-micrococci in animals, by injection into the right lung. With rabbits no success was obtained; while mice always died in from 18 to 28 hours. In the cavities of the pleura, partly in the fluid, partly in the lymphoid cells, were masses of micrococci, with all the characters of those of pneumonia, including the envelope. They were also found in the lungs and blood. With dogs and porpoises no result was obtained in some cases, while others were successful. Experiments were also made with mice by inhaling; when some only were infected.

The size of the micrococci and development of the envelopes differ considerably with men and other animals. Those of mice were, on the average, larger than those of man; those of porpoises were smaller, but with broader envelopes; those of dogs were scarcely larger than those of man, and the envelope comparatively narrow. The mode of preparation also has an influence on the size of the micrococci.

**Bacteria of the Cattle Distemper.***—The bacterium of the cattle-distemper has been hitherto known almost exclusively in the bacillus condition, not making its appearance in the blood till some ten hours before the death of the animal. F. Roloff has examined the blood in the early stages of the disease, and also those organs, especially the spleen and the lymphatic glands, in which the bacilli are first seen. In all these he found a large number of small round shining bodies or micrococci. The infection of other animals with blood containing these cocci, produced in them the ordinary distemper with its bacilli, showing that the two are stages of development of the same organism.

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* Arch. Wiss. u. Prakt. Thierheilkunde, ix. (1883). See Bot. Centralbl., xvii. (1884) p. 112.

**Passage of Charbon-bacteria into the milk of animals infected with Charbon.***—Chambrelent and A. Moussons have made the following experiments to determine whether the milk of a female in lactation affected with charbon contains the microbium of the infection. A cobaye, which had up to that time suckled its young, was inoculated with the charbon-virus. It died the next day, and a drop of blood taken from the ventricles of the heart was found to contain an immense quantity of bacteria. A drop of milk was taken from the mamillary gland by means of a sterilized tube, and placed in a Pasteur's "ballon" containing infusion of beef. At this time the milk presented a perfectly normal appearance, and showed no evidence of bacteria, although there were abundance in the blood. Four "ballons" treated in this way were left in the stove for two days; two were then quite limpid, one appeared to contain impurities; the fourth presented some flocci, and gave the appearance of a charbonized culture. It contained bacteria and interwoven filaments, but only in small numbers. A young cobaye was inoculated with this culture by means of a sterilized tube. It died in two days and its blood was found to contain bacteria. The rest of the culture, left in the stove, had in four days more assumed completely the characteristic appearance of charbon-cultures. A cobaye inoculated with it died the next day.

In a second experiment the milk was removed before the death of the animal. A young cobaye in lactation was inoculated with charbon-virus; the next day it was still alive. Milk was removed from it in the same way as before; four Pasteur's "ballons" were inoculated with it and placed in a stove. After four days one remained quite limpid; two had assumed the characteristic appearance of charbon-cultures; the fourth appeared to contain some foreign ferment. The two charbonized cultures contained great quantities of the characteristic filaments. Two cobayes inoculated with the fluid died the next day, presenting the characteristic lesions of charbon.

In a third experiment a large rabbit in lactation was inoculated with the same virus, which did not kill it. The milk of this rabbit displayed no bacteria, and the blood only a very few. Inoculation with the milk produced no signs of charbon-bacteria, and only one out of two with the blood.

The experiments show conclusively that bacteria are found in the milk of animals infected with charbon while they are still alive; but their number is enormously smaller than in the blood.

**Comparative Poisonous Action of Metals on Bacteria.**†—C. Richet has experimented on this subject, and gives a table of his results. The liquid was sea-water, neutralized urine, and commercial peptone, and the particular metal was added in gradually increasing quantity, in the form of chloride, until no bacteria were developed after forty-eight hours at 16°–20° C.

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* Comptes Rendus, xcvii. (1883) pp. 1142-5.

† Ibid., pp. 1004-6. See Journ. Chem. Soc.—Abstr., xlvi. (1884) pp. 351-2.

The amount of each metal which will kill fish is always much less than that required to prevent the development of bacteria. The marked poisonous action of ammonium, lithium, and potassium on fish and all animals is in striking contrast to the slight effect which these metals exert on plants and bacteria. Poisons may be divided into two classes, viz. general poisons, of which mercury is the most potent, which even in small quantities have a deleterious action on both plants and animals; and special poisons, such as potassium and ammonium salts, and the alkaloids, which are injurious only to animals, and exert little or no poisonous action on plants. The difference is probably due to the fact that poisons of the second class act only on nerve-cells, whereas those of the first class act on all cells. Possibly the action of ammonium and potassium salts may serve to distinguish between plants and animals in the lower forms of life.

**Micro-organisms in Soils.***—From examinations of a large number of samples, R. Koch found that the superficial layers of soil were very rich in germs of bacteria, particularly in bacilli. Micrococci were only found in places which had not been cleansed from decaying matter; the latter perished on heating the samples, but the bacilli did not, being mostly in the condition of spores, and it appears probable that they are introduced by means of manures and household offal.

The quantity of micro-organisms diminishes very rapidly with increase of depth, so that at the distance of one metre from the surface the earth is very free from them. P. Miquel attempts to estimate the number present in one gr. of soil, taken from a depth of 0·20 metre from the surface, and found in three samples: from Montsouris, 700,000 organisms; Gennevilliers, manured with liquid sewage, 870,000; Gennevilliers not so treated, 900,000.

The office of these minute organisms appears to be of great importance in the transformation of substances to forms suitable for plant-food.

**Bacteria and Microscopical Algæ on the Surface of Coins in Currency.**—Prof. P. F. Reinsch writes us as follows:—"Accidentally induced to examine microscopically the surface of a small silver coin, I made the observation of the presence of numerous *Bacteria* and microscopic unicellular algæ living in the incrustations and sediments which have been produced through constant use. I examined coins of various nations and of various value, and found my first observation perfectly confirmed. All silver and copper coins, several years in currency, show this curious vegetation of organisms of the lowest rank. It is observed best on coins twenty to thirty years old.

To observe this life, a small quantity of the sediment adhering to the prominences and in the cavities of the surface of the coin is scratched off with the top of a knife and put in a drop of distilled water on a slide, spread out in the water and immediately covered with a cover-glass.

Between the agglomerations of larger and smaller granules, scarcely dispersed fragments of fibres, and especially numerous granules of starch

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* Bied. Centr., 1883, pp. 581-2. Cf. Journ. Chem. Soc.—Abstr., xlvi. (1884) p. 486.

(in the most cases granules of wheat), are observed. In a short time numerous mobile minute bodies are seen, the mobility of which seems at first to be the well-known molecular motion, but is soon turned into the most active bacteroid motion. By using a higher power (500 diam.) we observe in the agglomeration various forms of bacteroid life, very well recognizable both by their constant relations of size and shape, and by the mode of motion peculiar to the various bacteroid types. There are rod-shaped *Bacteria* with oscillating and spiral motion, and globular bacteria with the peculiar rocking-oscillating motion. Sometimes all these forms of bacteroid life are found on one and the same coin; in most cases there are found on one coin more especially globular *Bacteria*, on another coin more rod-shaped *Bacteria*. The globular forms make up in the case of all coins the principal constituent of bacteroid life in the incrustation. *Spirillum* is not found very often, but by searching after it, and dispersing the substance under the cover-glass it is sure to be found in a great many cases. Of *Bacillus*, four to six divided rods of 0·0055–0·0074 mm. in length are found on all silver, copper, and bronze coins. The automobile motion of the bacteroid bodies, lasting for many hours, is instantly stopped with one drop of a solution of iodine or of concentrated glycerine placed on the margin of the cover.

Of the unicellular algæ in the incrustations of nearly all the coins hitherto examined, I have distinguished till now two very distinct and constant types, the characteristics of which are so clear and constant, that they can be identified with known types of algæ and classified in the system of algæ. There is one most minute *Chroococcus* and one unicellular alga which I think very nearly allied to the Palmellaceæ. The slightly tinctured cells of this *Chroococcus* of 0·00925 mm. diam., form minute globular bodies, composed of 4, 8, to 12 cellules. These globular bodies are clustered together, forming minute irregular masses, 0·02 mm. diam. The Palmellaceous alga has many times larger, thick-walled cells; the contents of which are mostly intensely tinctured. The cells are found in all states of division from two to more. Of the Palmellaceæ *Pleurococcus* is the type, coming the nearest to this new alga. The cells in the undivided state are found 0·009–0·01 mm. diam. The thickness of the wall of the cells is equal nearly to 1/10 the transverse diameter of the cells. The cells in their many-divided state do not exhibit the same regular and symmetrical disposition of the daughter-cells as the typical *Pleurococcus* (*P. vulgaris*).

In addition to these organisms there are found in the incrustations of the coins (besides undeveloped fungoid hyphæ), spores of various Cryptogams of various size and shape, belonging to the Hyphomycetes and the Coniomycetes.

It may be concluded from the constancy of the characteristics and of the occurrence of these two unicellular organisms, that their occurrence is a spontaneous one, just as is the case with a large number of these organisms of the lowest state, concerning both living and dead matter; in other words that these organisms have to be considered not as accidentally adherent substances but as organisms, which have their continual origin and seat in the incrustations of coins in currency. The discovery of the presence of these organic bodies (which, according to modern experiences, are generally recognized as important factors in the spread of epidemics) on objects so dispersed as coins, adds a new consideration in hygienic science. It seems also very probable that to the vital activity of these unicellular organisms, a share is due of the erosive process, perpetually going on on the surface of coins in currency.

The means for obviating the obnoxious influence of the organisms would simply consist in boiling the coins after a series of years of circulation, in a solution of caustic potash, and then cleaning the surface thoroughly from the incrustation."

The following is a description of the two new species:*—

*Chroococcus monetarum.* Cells minute, subglobose, angular, from 4 to 8 cells enveloped in a common mucilage and associated in small subglobose families. Diam. of cells 0·925 μ; diam. of families 0·46–0·56 μ.

*Pleurococcus monetarum.* Cells globose, with thick membrane, subtorulose (elevations 1/10 diam. of cell), undivided; from 2 to 8 cells associated in globose families; cell-contents brightly coloured. Diam. of cells 0·0074–0·011 mm.; diam. of families 0·011–0·0129 mm.

**Rabies.**†—L. Pasteur, with the assistance of MM. Chambrelent and Roux, has another communication on rabies. Inoculation has been effected either by applying the poison of rabies direct to the surface of the brain, or by injection into the blood. The former would appear to be a long and difficult operation, but we are assured that it may be well completed in twenty minutes, starting from the moment in which the animal was being subjected to chloroform.

Pasteur has already shown that the inoculation of the virus into the blood is most often accompanied by paralytic seizures without fury or barking, and that the first part to be affected is the spinal cord; and he has also already proved that the poison is to be found in the brain and spinal cord. He has since experimented with nerves and salivary glands, and he has been able to get poison effects with portions of the pneumogastric and sciatic nerves, as well as with the maxillary, parotid, and sublingual glands. It follows then that the whole of the nervous system is able to cultivate the rabic poison, and we find in this fact an explanation of the high degree of nervous excitement which is so often a characteristic of rabies. Poison placed in carefully sealed tubes is virulent after three weeks or a month, even when exposed to a summer temperature. The fluid of the central nervous system is sometimes, though not constantly poisonous: when limpid it is so, but not when distinctly opalescent. Cultivation experiments of the virus have not as yet been successful, but Pasteur is always able to distinguish the brain of a healthy from that of a rabid animal. Both, under the Microscope, exhibit an immense number of molecular granulations, but in the rabid brain they are finer and more numerous.

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* Flora, lxvii. (1884) pp. 173–6.

† Comptes Rendus, xcviii. (1884) pp. 457–63.

He is inclined, therefore, to think that the microbe of rabies is infinitely small, a mere dot in shape, and not like a bacillus or a dumbbell-shaped micrococcus.

The only method known at present by which these granulations may be isolated from the other and nervous elements is the following: —Virus taken from the brain of an animal that has died of rabies is injected into the veins of a rabid animal at the moment when asphyxia commences. In a short time the normal nervous elements disappear from the blood in which only the just-mentioned minute granulations are now to be found. These may be stained by anilin dyes, but as the author is careful to point out, it is not yet definitely proved that these granulations are the microbes of rabies.

It has been found that while the trepanation-experiments are succeeded by desire to bite and "rabid barking"—furious rabies—injection experiments produce only paralytic rabies. If, however, exceedingly minute quantities of virus are injected, furious rabies ensues. On the other hand these minute quantities extend the period of incubation, and if the poison is diluted beyond a certain extent the inoculation has no effect. But these minute and inoffensive doses do not give protection against the effect of larger doses.

In rare cases the effects of the poison disappear to reappear with mortal result after some days. Entirely negative results have been obtained in reference to the pretended diminution of the poison by the influence of cold and by its passage from the mother to the fœtus.

Especial attention has been given to the very important question of the alteration of the character of the virus, and it has been found that the passage of the rabic virus through several species does more or less profoundly modify its virulence. Pasteur and his assistants now possess a virus which gives rabies to the rabbit in seven or eight days, and that with remarkable constancy; another virus has a similar effect on guinea-pigs.

Pasteur has already made known the curious fact that he has in his laboratory some dogs that are refractory to the virus of rabies, but he has not till now been able to say whether that was due to their natural constitution or not. He now finds that it is not so, but that he can by a system of inoculations of different kinds, make any number of dogs refractory; indeed he has now twenty-three. For the present he confines himself to this statement, but it is clearly one of great importance, as man only becomes rabid directly or indirectly from the bite of a dog. He concludes: "Could not human medicine profit by the long duration of the period of incubation to try and establish in this interval of time, before the appearance of the first symptoms of rabies, the refractory condition of subjects that have been bitten? Much, however, remains to be done before this hope can be realized."

**Yeast-ferments.***—Continuing his researches on the ferment of beer, E. C. Hansen observes that there are in nature a large number of fungi belonging to the most distinct groups which are capable of developing saccharomyces-like cells, by budding in nutrient solutions; but differing from that genus in not forming endogenous spores. Some of these fungi induce alcoholic fermentation, behaving in this respect like *Saccharomyces cerevisiæ*.

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* Allg. Zeitschr. f. Bierbrauerei u. Malzfabrikat, 1883, p. 871. See Bot. Centralbl., xvii. (1884) p. 169. Cf. this Journal, iii. (1883) p. 252.

The author has made a careful examination of one of these unknown species. It propagates itself in beer-wort by budding, causing the higher fermentation, and showing in this respect a close relationship to *Saccharomyces ellipsoideus*. But under conditions where *S. cerevisiæ* would produce 6 vol. per cent. of alcohol, it produces scarcely 1·5 per cent. It also exhibits a great difference in its fermentive action, the chemical soluble ferment or invertin being entirely wanting, although it ferments saccharose as such. This establishes the fact frequently controverted, that saccharose can be directly fermented without previous immersion.

The fungus readily produces a perfect mycelium. Although its cells, when cultivated in beer-wort, altogether resemble typical *S. ellipsoideus* or *cerevisiæ*, they do not produce endogenous spores.

**Action of Cold on Microbes.***—R. Pictet and E. Yung find that various organisms, such as bacilli, when subjected to a temperature of 70° C. for 108 hours, and to 130° for 20 hours, are not destroyed; others, such as *Torula* and the vaccine microbe, lost their power of producing fermentation.

### Algæ.

**Fertilization of Cutleria.**†—E. de Janczewski has paid special attention to the development and mode of fertilization of *Cutleria adspersa*, growing at Antibes.

This species is strictly diœcious; but the male and female plants are often so intimately united at their base that it is practically impossible to separate them. They can only be distinguished by the different colours of their sori, orange in the male, very dark brown in the female plants. Each mature sporangium consists usually of 16 or sometimes of 32 cells, from each of which escapes a motile oosphere. This usually takes place early in the morning. The normal number of antherozoids produced in an antheridium is 128. The emission of antherozoids occurs at the same time as that of the oospheres; their period of motility does not exceed 12 hours at the outside. Their form and structure are precisely that of the Fucaceæ. Each of them has two vibratile cilia, and a bright orange granule. The motile oospheres bear a close resemblance to the zoospores of the Phæosporeæ, except that they are considerably larger. The whole of the oosphere is of a brown colour, except the anterior portion which constitutes a colourless beak. This beak bears at one side a slight swelling, to which are attached two vibratile cilia. The colourless protoplasm of the oosphere contains a number of brown chromoplastids, and of much smaller, colourless, highly refractive globules; there is no nucleus. Near the point of insertion of the vibratile cilia is a single large orange granule. The motility of the oospheres lasts as long as that of the antherozoids, and is equally affected by light.

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* Comptes Rendus, xcviii. (1884) pp. 747–9.

† Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 210–26 (2 pls.).

As long as the oospheres are in motion, the antherozoids display no affinity for them; but as soon as the oospheres have lost their cilia and come to rest, the antherozoids are attracted to them. They move rapidly round them, finally come in contact with them, lose their cilia, and become absorbed into their substance. A single antherozoid is sufficient to impregnate an oosphere.

The fertilized oosphere contains the two orange granules derived from the male and female elements. It immediately becomes invested with a cell-wall, and begins to germinate the next day, dividing first of all into two cells, one of which is much larger than the other.

Zoospores which germinate without fecundation, resembling those of *Zanardinia*, are also probably present. They are found in unilocular zoosporangia, and resemble the motile oospheres except in their much smaller size.

*Cutleria* exhibits in its structure several important variations from the Fucaceæ. The antheridia are pluricellular in the former, unicellular in the latter. The oospheres of the Fucaceæ are immotile, and do not contain any orange granules; except in the latter point they resemble the oospheres of *Cutleria* after they have come to rest.

The nearest affinity of the Cutleriaceæ appears to be with the Ectocarpaceæ. *Ectocarpus Lebelii* and *secundus* possess antheridia which produce antherozoids precisely resembling those of the Cutleriaceæ and of the Fucaceæ, and equally incapable of independent germination. They also have plurilocular sporangia exactly like those of Cutleriaceæ. The plurilocular sporangia of other species of *Ectocarpus* and of the Phæosporeæ generally must be regarded as female organs, and the bodies which emerge from them not as true zoospores, but as motile oospheres homologous to those of Cutleriaceæ, which, in default of male organs, germinate without fecundation, offering an example of constant parthenogenesis. The same is also probably the case in the pelagic *Cutleria multifida*. The unisporous sporangia of *Tilopteris*, *Haplospora*, and *Scaphospora* are evidently homologous with the plurilocular sporangia of *Ectocarpus*; their oospheres appear, under certain conditions, to germinate parthenogenetically.

The occurrence of parthenogenesis normally in the greater number of Phæosporeæ, and exceptionally only in the Cutleriaceæ, must be regarded as placing this family at the head of the group.

**Endoclonium polymorphum.**[*]—Under this name a new parasitic alga is described by M. Franke. It has been observed only on *Lemna gibba*, on which it occurs in two forms, one endophytic in the air-cavities beneath the stomata on the upper side of the frond; the other epiphytic, on all parts of the host. The two forms are connected by an imperfect alternation of generations; but the same form may also repeat itself through a number of generations. The zoospores of the endophytic protococcus-like form germinate after coming to rest, on the surface of the *Lemna*, and give rise to the stigeoclonium-like epiphytic form. This produces macrozoospores, with four cilia, which continue to repeat the same form, and microzoospores, which sometimes, without conjugation, either enter the air-cavities beneath the stomata, and develope the endophytic form, or repeat the epiphytic form on the surface of the host: at other times they conjugate, and the zygozoospore also probably enters the air-cavities and gives rise to the endophytic form.

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[*] Cohn's Beitr. Biol. Pflanzen, iii. (1883) pp. 365–76 (1 pl.).

When cultivated in a moist atmosphere the cells of the epiphytic form increase in size and multiply rapidly, and, like the microzoospores and macrozoospores, may pass into a resting condition, their cell-wall thickening, but without any formation of jelly. The apical cells of the filaments finally put out long apical points destitute of chlorophyll.

Both kinds of zoospore have a red eye-spot, and are formed by repeated bipartition, with the exception of the macrospores, which are produced singly in the sporangia. The macrospores are 13·5 μ long and 10 μ broad, and provided with four cilia; the microspores are biciliated, and 7·5 μ long by 3·5 broad. The endophytic form produces zoospores of one kind only, resembling the microzoospores.

The parasite occurs especially on the white dead parts of the *Lemna*, where it produces dark green spots visible to the naked eye.

**Godlewskia, a new Genus of Cryptophyceæ.***—E. de Janczewski has found, growing on *Batrachospermum* in a ditch near the botanic garden of Cracow, a new species and genus of algæ, to which he gives the name *Godlewskia aggregata*. It is distinguished at a glance from its host by its beautiful blue-green colour. Each individual consists of a basal flask-shaped cell or sterigma, and a number of smaller globular cells, borne in a row at its apex, conidia, formed by continued division of the sterigma. These conidia germinate directly, but do not separate easily from the parent sterigma, sometimes as many as two generations being found still attached to it, each basal conidium developing into a sterigma. *Godlewskia* must be assigned to the family Chamæsiphoneæ among Cryptophyceæ.

**Sexuality in Zygnemaceæ.**†—A. W. Bennett has investigated the reproduction of the Zygnemaceæ, with a view to the solution of the question:—Is it of a sexual character? De Bary, twenty-five years ago, and since then, Wittrock, have instanced what they have thought to be sexual differences between the conjugating cells, though most later writers rather ignore any essential physiological distinction. Mr. Bennett has directed his investigations chiefly to the genera *Spirogyra* and *Zygnema*, and from these he supports the inference of the above-mentioned authors. He finds there is an appreciable difference of length and diameter in the conjugating cells, that deemed the female being the larger. The protoplasmic contents pass only in one direction, and the change first commences in the chlorophyll-bands of the supposed male cells, with accompanying contraction of the protoplasmic contents. The genera *Mesocarpus*, *Staurospermum*, and the doubtful form *Craterospermum*, on the whole substantiate the view above enunciated of sexuality.

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* Ann. Sci. Nat. (Bot.), xvi. (1883) pp. 227-30 (1 pl.).

† Journ. Linn. Soc. (Bot.), xx. (1884) pp. 430-9.

**Movements of the Oscillarieæ.***—In addition to the oscillatory movements of the Oscillarieæ, creeping and rotating movements of the protoplasm are also to be perceived, especially in those species where the cell-wall is thin and flexible, as *Oscillaria tenerrima* and *ærugineo-cærulea*. These have been more closely investigated by A. Hansgirg. The oscillating motion commences as soon as the filament has become fixed to a substratum by means of the mucilaginous substance excreted on the surface of the cell-wall. This extremely thin layer of mucilage often forms a hollow tube behind the creeping filament. It is not coloured brown by iodine like protoplasm, and takes only a passive, not an active part in the movement of the filament. The motive power which causes the gliding motion of the filament on a solid substratum resides in the protoplasmic contents of the cells, and is connected with osmotic currents.

In the protoplasm which had escaped from the broken end of a filament of *O. princeps*, the author observed a number of amœboid cells, from 9 to 12 μ in diameter, nearly spherical in form, and putting out colourless pseudopodia about twice the length of the central body, and to these he attributes the motile power of the protoplasm of the filament. The so-called "cilia" which proceed from the terminal cells of the filament of *O. ærugineo-cærulea*, do not participate in its motion except passively, and are, according to the author, independent parasitic organisms of the nature of *Leptothrix*.

In all the cells of the filaments of *Oscillaria*, the turgidity is unusually great, and the dividing septa experience great differences of pressure from variations in the tension. The cause of the oscillating motion appears to be that the protoplasm takes up water more rapidly, and consequently swells to a greater extent, than the enveloping sheath of mucilage. Several species can retain their vitality to an extraordinary extent, and for a long time after losing their water and becoming completely dried up.

A series of experiments made with a variety of substances led the author to the conclusion that the movements of the Oscillarieæ are caused mainly by the osmotic forces and forces of imbibition, which act on the protoplasmic contents of the cells, and not to any external layer of protoplasm. In those species where the filaments are inclosed in an osmotic mucilaginous sheath, in which they move alternately backwards and forwards, this takes place chiefly by osmotic processes in the protoplasmic contents of the cells, in consequence of which the turgidity becomes greater alternately in the cell of each end of the filament. In those species which have no such sheath, variations in the turgidity are also brought about by variations in the exosmotic and endosmotic phenomena of the cells.

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* Bot. Ztg., xli. (1883) pp. 831–43 (1 pl.).

**Alveoli of Diatoms.***—A. Grunow considers that the perforation of the alveoli has been completely proved in diatoms from the Jutland cement-stone and from the London clay; but that this can only modify the previously adopted interpretation, since he considers that the diatoms from these localities have already begun to undergo dissolution—this being unquestionably the case in those from the London clay—in consequence of which the delicate closing membranes of the alveoli disappear first of all. He believes that whenever diatoms are accompanied by lime, and especially when iron pyrites is present, as is the case in these localities, alkaline reactions have been set up, which may have been very weak, but which always act more strongly on silica than even very strong acids. In valves treated with very strong acids the alveoli may sometimes be seen actually perforated; while others close by will still be closed. *Coscinodiscus oculus-iridis* and *C. Asteromphalus*—the former of which (in cement-stone) has open, and the latter unquestionably closed membranes—are so closely related to one another that no sharp line of demarcation can be drawn between them. The author has given a close examination to this group of diatoms from Franz-Josef Land; and believes that the alveoli are closed above and below by delicate membranes proceeding from the thickening-ring. In *Triceratium Favus* the upper one is sometimes furnished with small spines. He considers it very improbable that in nearly related forms there should be so great a diversity of structure as that between perforation and complete continuity of the valves.

◆

## MICROSCOPY.

### a. Instruments, Accessories, &c.

**Hensoldt's and Schmidt's Simplified Reading Microscopes.**†—Dr. C. Bohn refers to the necessity for insuring that the divisions of the micrometer of these instruments ‡ shall be a simple fraction of the magnified image of the circle divisions. If the distance of the latter from the objective is altered by moving the objective or the Microscope, the power is no doubt changed, but the image no longer coincides with the micrometer scale. Shifting the scale alone is of no use, for the same reason. The only course is to alter the distance of the objective from the circle divisions and the distance of the micrometer scale simultaneously in a proper ratio, the conditions for which he discusses. A Ramsden eye-piece must be used.

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* Bot. Centralbl., xvii. (1884) p. 67.

† Zeitschr. f. Instrumentenkunde, iii. (1884) pp. 87–8.

‡ See this Journal, ii. (1882) p. 548.

**Geneva Company's Travelling Microscope.**—This is a very ingeniously constructed instrument, shown set up in fig. 51, and as folded for travelling in fig. 52.

To fold it, the narrow curved support between the base and the uprights is turned back within the latter, a pin which fixes it in position (not shown) being first withdrawn from the base. The uprights are then brought down to meet the base, the body-tube, stage, and mirror being at the same time swung so as to be horizontal. The base consists of an open frame only, but is heavy enough to give complete steadiness.

Fig. 51.

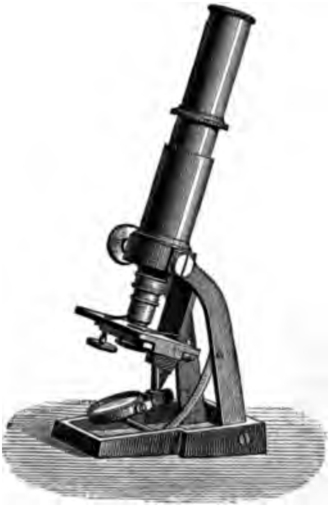
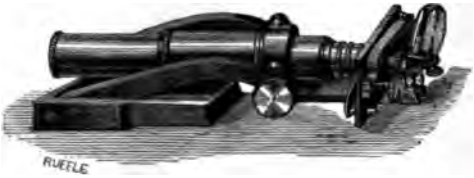


Fig. 52.



The milled head seen on the right of the body-tube clamps the socket of the latter between the uprights, so as to prevent it altering its inclination. The fine adjustment is effected by tilting the stage at one end by the screw beneath it.

When folded, the instrument measures 7½ × 3 in. × 1¾ in.

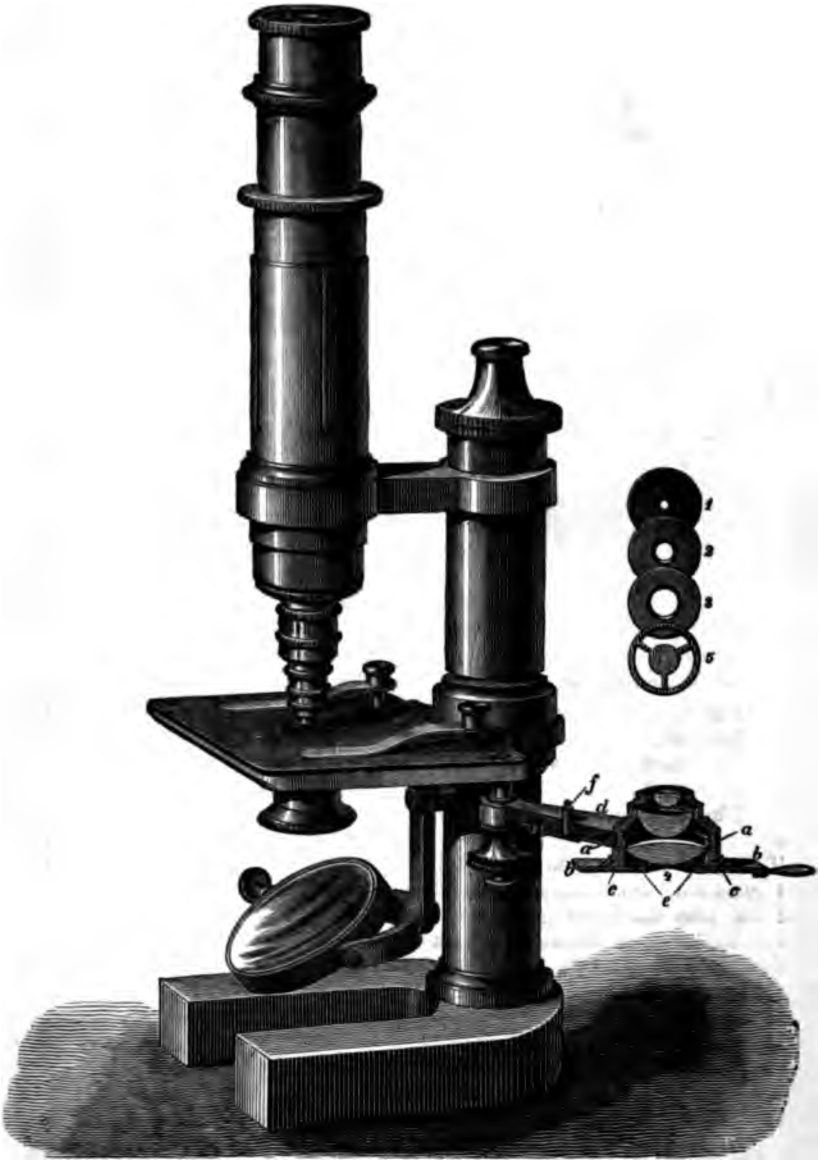
**Reichert's Microscope with modified Abbe Condenser.**—C. Reichert, of Vienna, with his medium stand (No. III.) supplies a modified form of Abbe condenser, shown in fig. 53, with which may be contrasted the original form by Zeiss (fig. 54).

The optical combination, consisting of three lenses with an aperture of 1·30 N.A., is screwed in a ring *a* attached to an arm *d*. This arm revolves on a pivot beneath the stage, so that it can be turned away from the stage, as shown in the figure. The fitting *c* of the lower lens has inner grooves to receive the diaphragm slide *b*, which can be drawn out entirely, for changing the five diaphragm-stops which drop into an aperture at *e*, or partially (to the right or left), so that the aperture may lie eccentrically to the optic axis for oblique illumination. A spring-pin falling in three holes marks the central or extreme lateral positions of the slide. The lenses with the diaphragm slide can be rotated in the ring, so that all azimuths of obliquity can be obtained. The pin *f* fits into a hole beneath the stage when the condenser is centered.

A slide beneath the stage for the ordinary cylinder diaphragms can be used when required on the condenser being turned aside.

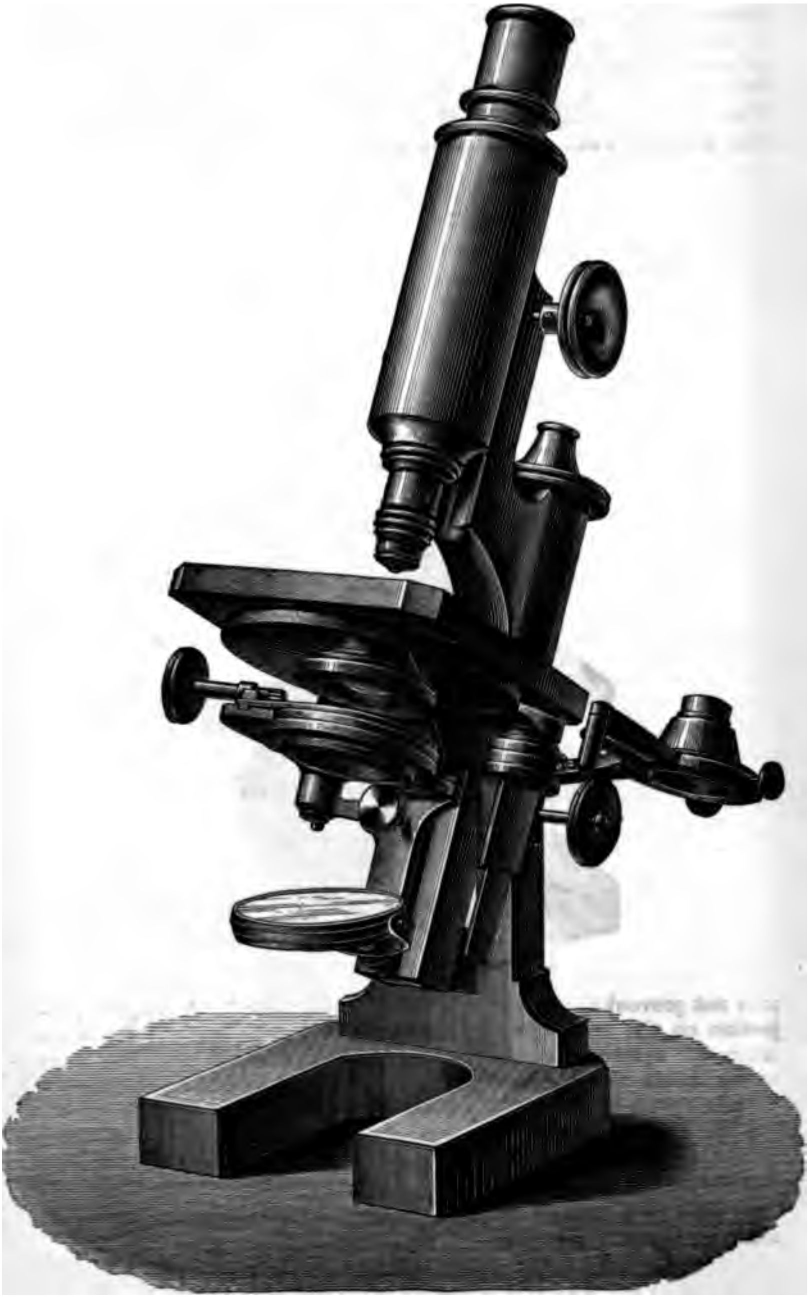
This apparatus seems to supply effectively the want which has long been felt for an adaptation of the Abbe condenser to the smaller

FIG. 53.



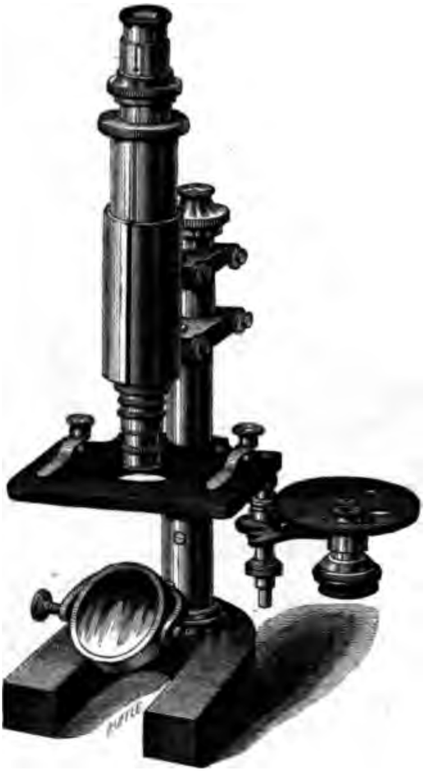
stands, though some of the advantages of the original form must necessarily be lost in such a case.

FIG. 54.



**Reichert's Polarization Microscope.**—This (fig. 55) is an inexpensive form of stand by C. Reichert, the chief peculiarity of which is that the wheel of diaphragms with five apertures rotates at the end of a horizontal arm, which, as with the condenser in the preceding form, swings on a pivot away from the stage, as shown in the figure. The diaphragm-plate is raised above the arm on a vertical axis, so that the tube attached to the largest aperture to hold the polarizer may not prevent the complete rotation of the plate.* A notched projection on the arm falls against a second spindle beneath the stage when the apertures of the diaphragm-plate are central. The tube which holds the polarizer has a rotating fitting, and carries the polarizer with it.

FIG. 55.



The analyser fits over the eye-piece without any attachment, which would seem to be undesirable, even though the Microscope can only be used in an upright position.

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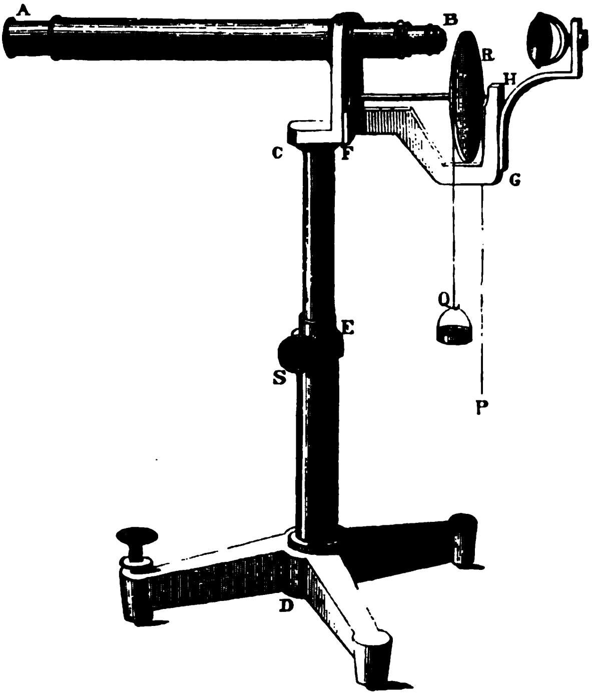
* When the polarizer is in place the plate cannot rotate completely, but no rotation is then required.

**Reinke's Microscope for observing the Growth of Plants.**[*]—J. Reinke, amongst other apparatus for observing the growth of plants, devised the instrument shown in fig. 56.

A tripod D supports a hollow pillar S in which slides a second pillar C E which can be raised to a height of 32 cm. from the table and is fixed with a clamp screw. To the latter pillar is attached a horizontal Microscope A focusing by the eye-piece and magnifying about 100 times. In front of the objective B is a glass wheel R 6 cm. in diameter with a grooved edge which runs very easily on two fine steel points let in the bent arm F G shown in the figure. A mirror on a second arm H illuminates the field of view.

Fig. 56.



A thread P passes over the groove in the wheel, the end of which is attached to the plant under examination, and at the other is a weight Q to keep the thread stretched. The circumference of the wheel for 10 cm. is graduated in half millimetres, and each millimetre is numbered. In the body-tube of the Microscope is a micrometer scale with 50 divisions. This is to be adjusted so that the 0 and 50 of the scale exactly coincide with two consecutive divisions of the wheel. The half millimetres of the wheel can then be read to 1/50ths (= 0·01 mm.).

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[*] Bot. Ztg., xxxiv. (1876), pp. 65–9, 91–5, 105–43, 145–60, 169–71 (2 pls.).

As the plant grows the wheel revolves, and the extent of the revolution is read on the wheel and scale by the aid of the Microscope. If the weight reaches the table, the movable pillar can be drawn out, and when the divisions on the 10 cm. of the wheel are passed over it can be brought back to 0 again by gently raising the weight.

**Tetlow's Toilet-bottle Microscope.**[*]—D. Tetlow has patented the following instrument, the specification of which we give verbatim without any attempt at an abstract, venturing only to emphasize one paragraph by italics of our own. The figures are also facsimile.

"To all whom it may concern: Be it known that I Daniel Tetlow, of the city and county of Philadelphia, and State of Pennsylvania, have invented a new and useful Improvement in Microscopes, which improvement is fully set forth in the following specification and accompanying drawings, in which—

Fig. 57 is a perspective view of a Microscope embodying my invention with central vertical sections thereof in line *x x*.

My invention consists of a Microscope having a body of the form of a bottle and the eye-piece removably fitted to the neck thereof, the construction, operation, and advantages being hereinafter set forth.

Referring to the drawings, A represents the body of a Microscope, the same being essentially of the form of a glass bottle having a closed bottom which is integral with the body; and B represents the eye-piece, consisting of the lens or glass C and metallic cap or holder D, the lens being properly set in the holder, and the latter removably fitted on the neck of the bottle.

E represents a base on which the bottle is stood, the same being formed of metal and receiving the bottom of the bottle, said bottom being shouldered, so as to properly set in the base and provide a neat joint for the parts.

While I have described the holder D and base E as metallic, sheet metal being preferred, it is evident that they may be formed of any suitable material and the base may be part of the glass.

The eye-piece is removed and an object to be examined placed in the bottle. The eye-piece is then restored, and the object may then be viewed through the lens C, as in Microscopes.

The body, being of the form of a bottle, has the following advantages: The object is not liable to be lost or displaced. It may be seen through the wall of the body and comparisons readily made as to its natural and magnified conditions and remain in the body for further examination, as the bottle provides an inclosure, the access to which being the mouth of the bottle, and this is covered by the lens C.

*Another object of the invention is to employ the body* A, *primarily*,

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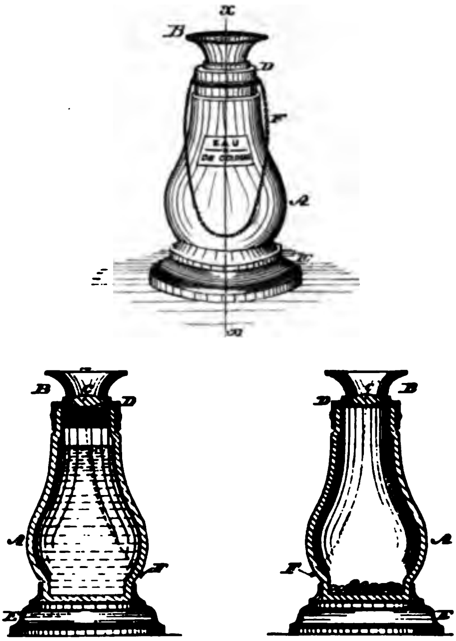
[*] Specification forming part of U.S.A. Letters Patent No. 287,978, dated November 6, 1883. Application filed August 24, 1883.

*as a receptacle for some material or substance, such as perfumery. When the body is filled, it is corked and the eye-piece fitted to the neck, an attractive and convenient toilet-bottle thus being produced. The cork is concealed by said eye-piece, so that unauthorized persons will experience some difficulty in abstracting the perfumery. When the perfumery is exhausted, the cork is thrown away and the service of the Microscope begins, said service being similar to that hereinbefore stated.*

FIG. 57.



To the eye-piece is secured a chain, F, whereby the device may be readily carried, whether as a Microscope or toilet-bottle.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

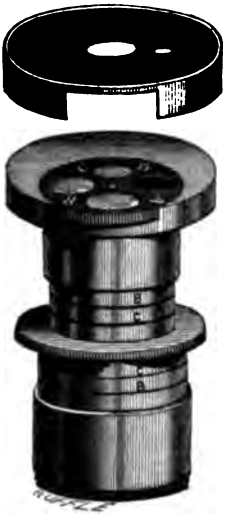
1. A glass bottle having a closed bottom integral with the body thereof and an open mouth, in combination with an eye-piece closing said mouth, formed of a lens and holder therefor, said mouth being adapted to contain a cork, substantially as and for the purpose set forth.

2. A bottle provided with a removable eye-piece and a base and chain, substantially as and for the purpose set forth."

**Griffith's Multiple Eye-piece.**—Mr. E. H. Griffith sends us the eye-piece (fig. 58) which he has devised.

A disk at the top of the eye-piece, with projecting milled edge, carries different eye-lenses which by rotation are brought successively into the optic axis. An aperture in the cap shows by a letter which lens is in place.

FIG. 58.



The upper tube to which the eye-glass disk is attached can be drawn out as shown in the figure, and the lower one, in which the field-lens is set, can be similarly drawn out.

Rings marked B and C show the proper position for each power, and when entirely closed, the eye-piece is of the proper length for a D eye-piece.

It was intended by the inventor to have a slit with stops for regulating the length of the eye-piece, and that a revolving diaphragm-disk should also be included, but these have not yet been added.

As to the utility of the eye-piece, it may be pointed out that whilst it would be very convenient to be able to obtain different eye-piece powers by simply rotating a disk, yet most of the advantage is lost by the necessity of withdrawing the eye-piece from the tube to alter its length—a process which would occupy as long a time as would be required to insert a different eye-piece. Moreover, it is optically impracticable to make use of the same field-lens for B, C, and D eye-pieces.

**Francotte's Camera Lucida.***—P. Francotte thinks that Beale's camera lucida has a capital defect; the image is formed on the reflector too close to the eye-piece. The consequence is that the whole field is not visible at one time to the eye; whilst, for instance, the centre can be seen, the periphery is invisible; and in order to see all parts of the field, it is necessary to move the eye. Besides this, the short space left free between the eye-piece and the glass is very inconvenient.

To obviate this he replaces the eye-piece by a single lens, giving an image which is reflected by an inclined glass plate or a mirror. The inclination of the reflecting surface may vary between 40° and 50°, according to the point of the table upon which the image is to be projected. The image is erect, and the whole field is included.

The apparatus can be easily and very cheaply constructed. An ordinary lens (3 to 6 times) in a tube of cardboard is used as the eye-piece. The tube is cut obliquely, so that, on the elliptical section, a thin plate of glass or a mirror may be applied. On the upper surface an opening is made exactly over the place where the image is reflected.

By adopting the same principle and replacing the large prism of

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* Bull. Soc. Belg. Micr., x. (1884) pp. 77-9.

Oberhäuser's camera by a mirror, the eye-piece by a single lens, and the small prism by a reflecting glass plate or a mirror, a convenient instrument is obtained which will not necessitate the inclination of the Microscope.

**Rogers's New Eye-piece Micrometer.***—"Professor W. A. Rogers, of Harvard Observatory, has again laid microscopists under obligation by making an eye-piece micrometer for high oculars. It is a cover-glass of proper size to fit above the diaphragm of a 1/2 in. or 3/8 in. ocular, ruled in a scale with the fifth and tenth lines longer, and so fine as to need the magnifying power of the eye-lenses to separate the lines well. The high-power ocular separates also the striæ of diatoms, or other minute subdivisions of objects, and the scale enables one to count them with a readiness and ease which has not before been possible. It is a simple and inexpensive thing, that takes the place of the most expensive spider-web micrometers."

**Geneva Co.'s Nose-piece Adapters.—Thury Adapters.**—Prof. M. Thury takes exception to the remark at p. 284 that these adapters do not "differ in principle from the nose-pieces of Nachet and Vérick."

The first adapter was, he says, made in October 1863 after his designs for Count Castracane, and another in 1865 for Prof. E. Claparède. A Microscope exhibited by the Geneva Co. at the Paris Exhibition in 1867 was fitted with a similar adapter and was accompanied by a written description. At the 1878 Exhibition the modified movable form was exhibited. M. Nachet, who adopted the fixed form in 1877, "loyally termed it the 'Pince-Thury.'" It was after the 1878 Exhibition that the movable form came to be made by others.

Prof. Thury's apparatus was evidently therefore the precursor of all such contrivances.

**Selection of a Series of Objectives.**—Several writers have published their views on this subject, differing (with the exception of Dr. Carpenter) more or less from those put forward by Prof. Abbe in his paper on the "Relation of Aperture and Power."

Dr. G. E. Blackham† selects "as a set of powers sufficient for all the work of any microscopist the following:—

One 4 in. objective of 0·10 N.A. = 12° air angle nearly.
One 1 in. objective of 0·26 N.A. = 30° air angle nearly.
One 1/6 in. objective of 0·94 N.A. = 140° air angle nearly.
One 1/8 in. objective of 1·42 N.A.

The first two to be dry-working objectives without cover correction, the third to be dry-working with cover correction, and the fourth to be a homogeneous-immersion objective with cover correction, and all to be of the highest possible grade of workmanship. The stand . . . to be furnished with six eye-pieces, viz. 2 in., 1 in., and 3/4 in. Huyghenian, and 1/2, 1/3, and 1/4 in. solid. The following table shows the application of these powers to all grades of work, from that which is ordinarily done with a pocket lens to the extreme limits of microscopical vision :—

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* Amer. Mon. Micr. Journ., v. (1884) p. 52.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 33-41, 227-31.

| No. of lines to 1 in. | N. A. required to resolve. | Equivalent angular aperture. | Amplifying power needed to give apparent size of 100 to 1 in. at 10 in. | Amplifying power actually used. | How obtained. | |
|---|---|---|---|---|---|---|
| | | | | | Objective. | Eye-piece. |
| 100 | Less than 0·10 | Less than 10° air | None | None | Naked eye | Naked eye |
| 500 | Less than 0·10 | Less than 10° air | 5 | 12½ | 4 in. of 0·10 N.A. | 2 in. |
| 5,000 | Less than 0·10 | Less than 10° air | 50 | 50 | 1 in. of 0·26 N.A. | 2 in. |
| 10,000 | 0·11 | 12° 38′ air | 100 | 100 | .. | 1 in. |
| 20,000 | 0·21 | 24° 16′ „ | 200 | 200 | .. | 1/2 in. |
| 30,000 | 0·32 | 37° 20′ „ | 300 | 300 | 1/6in. of 0·94 N.A. | 2 in. |
| 40,000 | 0·41 | 48° 26′ „ | 400 | 600 | .. | 1 in. |
| 50,000 | 0·52 | 62° 40′ „ | 500 | 600 | .. | 1 in. |
| 60,000 | 0·63 | 78° 08′ „ | 600 | 600 | .. | 1 in. |
| 70,000 | 0·73 | 93° 48′ „ | 700 | 800 | .. | 3/4 in. |
| 80,000 | 0·84 | 104° 17′ „ | 800 | 800 | .. | 3/4 in. |
| 90,000 | 0·94 | 140° 16′ „ | 900 | 1200 | .. | 1/2 in. |
| 96,000 | 1·00 | 180° air, 82° 17′ homogeneous imm. fluid | 960 | 1066 | 1/8 in. of 1·42 N.A. | 3/4 in. |
| 100,000 | 1·04 | 86° 21′ „ | 1000 | 1066 | .. | 3/4 in. |
| 110,000 | 1·15 | About 98° „ | 1100 | 1600 | .. | 1/2 in. |
| 120,000 | 1·25 | About 110° „ | 1200 | 1600 | .. | 1/2 in. |
| 130,000 | 1·35 | About 125° „ | 1300 | 1600 | .. | 1/2 in. |
| 136,888 | 1·42 | About 138° „ | 1368 | 1600 | .. | 1/2 in. |

. . . It has not been my purpose to lay down any single set of objectives as the only proper one, but to indicate the principles on which selection should be made, and the relation of aperture to amplifying power, and to show that there is at present no good theoretical reason for the use of objectives of greater amplifying power than the 1/8 in."

Dr. Blackham, it will be seen, advocates the use of eye-pieces as high as 1/4 in. which is largely in excess of Prof. Abbe's figures, which do not go beyond an amplification of 15 times.*

Mr. J. D. Cox believes † " Dr. Blackham has the verdict of experience with him when he says four or five lenses with a proper number of eye-pieces will cover the whole range of microscopical examination. In such a number of lenses you may get all the necessary combination of the three qualities of angle, power, and working distance which you may need. Different investigators may choose different series, but no one need have a greater number in the series. Economy is to be considered in deciding whether we shall choose one or another lens; but this is also consistent with the statement that all the elements, including economy, may be combined in such a small series. The lowest glass may be anything from a 1½ in. to a 3 in. If of an angle of 20° to 25° it will have plenty of working distance and penetration. The next glass should be of 40° angle, or very near it, as this is the maximum normal angle for binocular vision of opaque objects. Its working distance should be enough to allow the use of dissecting-needles under it, and the easy illumination of dry opaque objects. These conditions are found in good glasses ranging from 1 in. to 1/2 in. objectives. The third glass should also be a dry glass, having working distance enough to accommodate work with the animalcule-cages and compressors, and upon rough histological material. Its angle should be from 100° upwards, to as wide an angle as is consistent with the necessary working distance. These conditions are found in glasses ranging from 4/10 in. objectives to 1/6 in. Beyond the three lenses thus generally described, a single immersion lens of widest possible angle seems to give all the advantages that can be attained in the present condition of the art of making objectives.

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* See this Journal, iii. (1883) p. 808.

† Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 229–30.

In the third and fourth of the series, the angle should be the widest consistent with the other conditions specially named, and this is the only demand of the practical microscopist in which, as it seems to me, the phrase 'wide angle' can have any appropriate place."

Dr. J. Edwards Smith * says that he has practically, for the past four years, confined himself to the use of four object-glasses, namely, a 1 in. or 2/3 in. of 45° or 50°, a 1/2 in. of 38°, a 1/6 in. immersion, balsam angle ranging from, say 87° to 95°, according to the position of its collar, and a 1/10 in. immersion having a constant angle of 100°. Of the last two glasses, the 1/6 in. has a working distance of 1/50 of an inch. The 1/10 in. will work readily through covers 1/100 of an inch thick. A large amount of his work is on urinary deposits. For the examination of malignant growths and for minute pathology generally, a dry 1/4 in. of 100° is in reserve.

Mr. E. M. Nelson's † view is to give the beginner a 1½ in. and a 2/3 in.; later on a 1/6 in. may be added, and as a higher power a 1/12 in. immersion of 1·43 N.A. "For all working purposes the battery would then be complete, and the microscopist equipped to repeat any results hitherto obtained. As luxuries, a 3 in., 1/3 in., and 1/25 in. might be got. It sometimes happened that the high initial magnifying power of the 1/25 in. enabled the observer to find some hitherto unknown object, or portion of an object, more easily than with the 1/12 in.; but when once found its details of structure would be better made out with the 1/12 in. So far it had not been possible to construct a 1/25 in. as perfectly as a 1/12 in., nor with so high an aperture; hence it would rarely bear any eye-piece beyond the lowest. The 1/12 in., however, with proper manipulation, would bear the 1 in. eye-piece, and then reveal structure that could not be made out with 1/25's, as hitherto constructed.

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* 'How to see with the Microscope,' 1880, pp. 202, 203, and 206.

† Engl. Mech., xxxix. (1884) p. 48.

"Half-inch objectives had been made with apertures of 80°. Some authorities had declared that 40° was the highest aperture that could be usefully employed with that focal length. He had obtained one of the best examples of the 1/2 in. of 80°, and had made a careful series of trials with it. He had applied diaphragms above the back combination to cut down the aperture to 60° and 40° respectively, and the results might be briefly told. Taking the proboscis of the blow-fly and viewing it with the 1/2 in. diaphragmed down to 40° aperture, and arranging the illumination in the most favourable manner, he noted every detail of the picture, the sharpness and blackness of the points of the bristles, the transparency and clearness and general precision of the image; then removing the diaphragm behind the lens, he increased the aperture to 60°, and he found the image improved in every way. Increasing the aperture to the fullest extent, 80°, gave no advance upon the quality of image seen with 60° up to the 1 in. eye-piece; for this reason he concluded that 60° was the really useful aperture for a 1/2 in., and gave as much resolving power as the eye could well sustain with that combined power. No doubt the extra 20° would give the lens a higher resolving power with a stronger eye-piece, but he thought that might be better obtained with a lens of shorter focal length."

Mr. Nelson gives[*] the following table of apertures for object-glasses (with 1 in. eye-piece on a 10 in. tube), and says that "if ideal perfection is to be reached, the values given in the above table must be aimed at."

| In. | N.A. | | ° |
|---|---|---|---|
| 3 | ·08, | air angle | 10 |
| 2 | ·12, | „ | 15 |
| 1½ | ·17, | „ | 20 |
| 1 | ·26, | „ | 30 |
| 2/3 | ·39, | „ | 46 |
| 1/2 | ·52, | „ | 63 |
| 4/10 | ·65, | „ | 81 |
| 1/4 | 1·04, | „ water angle | 103 |
| 1/5 | 1·3, | crown glass angle | 117 |
| 1/6 | 1·56, | which has yet to be constructed. | |

It will be seen that there is a wide divergence between Mr. Nelson's and Prof. Abbe's figures. For instance, for N.A. 0·65 Prof. Abbe suggests an objective of 1/8 in. and Mr. Nelson a 4/10 in.

Lastly, we may give Dr. W. B. Carpenter's views as expressed in his latest publication on the subject.[†]

"The 1/8 in. is (according to the writer's experience, which is confirmed by the theoretical deductions of Prof. Abbe) the lowest objective in which resolving power should be made the primary qualification,—the 1/6, 1/5, 1/4, and 4/10 in. being specially suited to kinds of biological work in which this is far less important than focal depth and dioptric precision. This view is strengthened by the very important consideration that the resolving power given by wide aperture cannot be utilized, except by a method of illumination that causes light to pass through the object at an obliquity corresponding to that at which the most divergent rays enter the objective. Now, although in the case of objects whose markings are only superficial such may not be productive of false appearances (though even this is scarcely conceivable), it must have that effect when the object is thick enough to have an internal structure; and the experience of all biological observers who have carried out the most delicate and difficult investigations is in accord, not only as to the advantage of direct illumination, but as to the deceptiveness of the appearances given by oblique, and the consequent danger of error in any inferences drawn from the latter. Thus, for example, the admirable researches of Strasburger, Fleming, Klein, and others upon the changes which take place in cell-nuclei during their subdivision can only be followed and verified (as the writer can personally testify) by examination of these objects under axial illumination, with objectives of an angle so moderate as to possess focal depth enough to follow the wonderful differentiation of component parts brought out by staining processes through their whole thickness.

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[*] Engl. Mech., xxxviii. (1883) pp. 367–8.

[†] 'Encyclopædia Britannica,' 9th ed., xvi. (1883) pp. 269–70.

The most perfect objectives for the ordinary purposes of scientific research, therefore, will be obviously those which combine exact definition and flatness of field with the widest aperture that can be given without an inconvenient reduction of working distance and loss of the degree of focal depth suitable to the work on which they are respectively to be employed. These last attributes are especially needed in the study of living and moving objects; and in the case of these, dry objectives are decidedly preferable to immersion, since the shifting of the slide which is requisite to enable the movement of the object to be followed is very apt to produce disarrangement of the interposed drop. And, owing to the solvent power which the essential oils employed for homogeneous immersion have for the ordinary cements and varnishes, such care is necessary in the use of objectives constructed to work with them, as can only be given when the observer desires to make a very minute and critical examination of a securely mounted object."

A table is then given which in addition to the magnifying-powers of objectives with the A and B eye-pieces also "specifies the angle of aperture which, in the writer's judgment, is most suitable for each. He has the satisfaction of finding that his opinions on this latter point, which are based on long experience in the microscopic study of a wider range of animal and vegetable objects than has fallen within the purview of most of his contemporaries, are in accordance with the conclusions drawn by Professor Abbe from his profound investigations into the theory of microscopic vision, which have been carried into practical accomplishment in the excellent productions of Mr. Zeiss." An extract from the table will be found on the next page.

"For ordinary biological work, the 1/8, 1/10, and 1/12 objectives, with angles of from 100° to 200°, will be found to answer extremely well if constructed on the water-immersion system."

| Focal Length. | Angular Aperture. | Focal Length. | Angular Aperture. |
|---|---|---|---|
| in. | ° | in. | ° |
| 4 | 9 | 1/4 | 50–80 |
| 3 | 12 | 1/5 | 95 |
| 2 | 15 | 1/6 | 110 |
| 1½ | 20 | 1/8 | 140 |
| 1 | 30 | 1/10 | 150 |
| 2/3 | 40 | 1/12 | 160 |
| 1/2 | 45 | 1/16 | 170 |
| 4/10 | 70 | | |

"It must be understood that there is no intention in these remarks to undervalue the efforts which have been perseveringly made by the ablest constructors of microscopic objectives in the direction of enlargement of aperture. For these efforts, besides increasing the resolving-power of the instrument, have done the great service of producing a vast improvement in the quality of those objectives of moderate aperture which are most valuable to the scientific biologist; and the microscopist who wishes his *armamentum* to be complete will provide himself with objectives of those different qualities as well as different powers which shall best suit his particular requirements."

**"High-angled" Objectives.**†—Dr. J. Edwards Smith "prefers to regard as 'high-angled,' any, and all glasses, without reference to their focal lengths, which are endowed with the widest apertures obtainable. If this be accepted, then it will occur that a 1 in. of 50° should be classed as a high-angled objective, and similarly a 2 in. of 25°. And, again, it would also then occur that a 1/6 in. of 130°, which fifteen years ago ranked as a wide, would now be classed as a glass of medium power."

**Zeiss's A* Variable Objective and "Optical Tube-Length."**—The demonstration of the important influence of "optical tube-length" on the magnifying power of the Microscope explains what has hitherto seemed a curious anomaly in the action of this objective.

It will be remembered that it has a considerable range of power according as its two lenses are "closed" (when they are 44 mm. apart) or "open" (when they are at a distance of 52 mm.), the closing and opening being effected by rotating the collar on the objective.

In the closed position the equivalent focal length of the objective is 54·1 mm., and in the open 39·7 mm., or a ratio of approximately 4 : 3. The power of the Microscope is however increased not in the ratio of 3 : 4 only, but of 3 : 5·28.

The explanation of this difference is found in the fact that $\Delta$, or the optical tube-length, varies considerably according to the position of the lenses of the objective. When they are closed the posterior focal plane is 153·6 mm. from the back lens of the objective, but when open 125·7 mm. only. $\Delta$ is therefore (with a tube-length of 10 in. or 250 mm. from the back lens of the objective to the anterior focal plane of the ocular) $250 - 153 \cdot 6 = 96 \cdot 4$ mm., *or* $250 - 125 \cdot 7 = 124 \cdot 3$ mm.

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† 'How to see with the Microscope,' 1880, p. 104. Cf. also p. 146.

In the formula, therefore, for the magnifying power of the Microscope as a whole

$$N = \frac{250\ \Delta}{f\,\phi}$$

($f$ and $\phi$ being the focal lengths of the objective and ocular respectively), N is in the one case 17·8 and in the other 31·3, assuming $\phi$ to be 25 mm.

Those who are interested in optical formulæ may like to have before them the method by which (1) the focal length of the objective and (2) the distances of its posterior focal plane are determined, according to the improved methods of Prof. Abbe, of which we hope to give a more detailed account later.

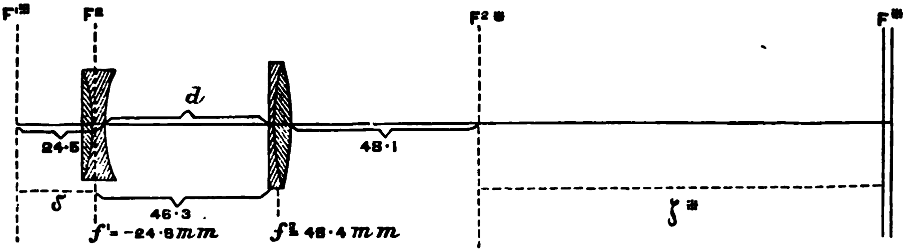
(1) To determine the focal length $f$ of the combination, we require to know only the focal lengths $f_1$ and $f_2$ of the two lenses, and the position of their anterior and posterior focal planes, whence we derive $f$ according to the formula

$$f = -\frac{f_1 f_2}{\delta}$$

($\delta$ being the distance of the posterior focal plane of the first lens † from the anterior focal plane of the second lens).

Thus suppose in fig. 59 that we have given $f_1 = -24·8$ mm. and $f_2 = 48·4$ mm., we require only to determine $\delta$ to solve the equation.

Fig. 59.



We can determine $\delta$ from the distances (supposed to be given) of the focal planes from the respective lenses, the distance of the posterior focal plane of the first lens $F_1^* = 24·5$ mm. and that of the anterior focal plane of the second lens $F_2 = 46·3$ mm. For the diagram shows that if from the total distance between $F_1^*$ and the front of the second lens (which is made up of the variable distance between the lenses $d$ and the quantity 24·5), we deduct the distance 46·3 mm. of the focal plane $F_2$ from the second lens we shall have the distance $\delta$.

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† The first lens being a plano-concave the *posterior* focal plane (i. e. which relates to the posterior medium, or to the image) is in *front* of the lens, and not, as with convex lenses, at the back.

Thus, according as the lenses are closed or open ($d$ = 44 mm. or 52 mm.),

$$\delta = 44 + 24 \cdot 5 - 46 \cdot 3 = 22 \cdot 2$$
$$= 52 + 24 \cdot 5 - 46 \cdot 3 = 30 \cdot 2.$$

Having thus found $\delta$, $f$ is also found, as it is

$$\frac{24 \cdot 8 \times 48 \cdot 4}{22 \cdot 2} = 54 \cdot 1,$$

or

$$\frac{24 \cdot 8 \times 48 \cdot 4}{30 \cdot 2} = 39 \cdot 7.$$

(2) The second step is to find the distance of the posterior focal plane $F^*$ of the combination, which being deducted from 10 in. gave us $\Delta$.

This distance, as the diagram shows, is made up of two quantities, one being the distance of the posterior focal plane $F_2{}^*$ of the second lens, which is supposed to be given, and = 48·1 mm., and the other, an unknown quantity, which we will call $\zeta^*$. This unknown quantity may be determined from the known quantities of $f_2$ and $\delta$ by the formula

$$\zeta^* = \frac{(f_2)^2}{\delta}.$$

It is therefore

$$\frac{(48 \cdot 4)^2}{22 \cdot 2} = 105 \cdot 5,$$

or

$$\frac{(48 \cdot 4)^2}{30 \cdot 2} = 77 \cdot 6,$$

according as the lenses are open or closed.

Adding these values of $\zeta^*$ to 48·1 we get the figures given above as the distance of the posterior focal plane from the back lens, i. e. 153·6 or 125·7.

The focal length of the objective and the distance of its posterior focal plane are thus very readily found, without elaborate calculations, by simply knowing the focal lengths and the position of the focal planes of the separate lenses, data which can be obtained very simply and without the necessity of knowing anything about the formulæ on which the objective is constructed or the refractive index of the glass of which its lenses are made. We hope, as we have said, to return to this subject hereafter and in more detail.

**Queen's Spot-lens Mounting.**†—In order to overcome as far as possible the difficulty J. W. Queen and Co. have felt in fitting the spot-lens to instruments of various patterns (some with movable substage and some with fixed tube, the latter at varying distances from the upper surface of the stage), they have devised the following mount:—

The tube A (figs. 61 and 62) is made of standard size to fit the usual English and American substage or accessory tubes. The tube B carries a third tube C (blackened inside), sliding easily within it. Securely mounted in the latter tube is the spot-lens, which thus may be accurately focused upon the object; and when once adjusted for any stand, there is no occasion to alter it. If the small tubes be only 1/2 in. or 5/8 in. in length, the focusing range is a long one.

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† Micr. Bulletin, i. (1884) p. 11 (3 figs.).

Fig. 60.

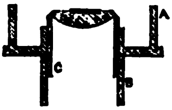

Fig. 61.

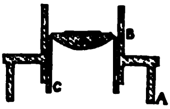

Fig. 62.

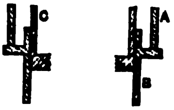

Fig. 60 shows the instrument as fitted to a Microscope which has the fixed tube beneath the stage. By reversing, as shown in fig. 61, the same mount may be used equally well in the movable substage of larger instruments.

They have also applied the same device to the usual substage Society-screw adapter, for carrying achromatic condenser or objective used as such (fig. 62).

The inside diameter of the tube C in this case is made 1⅛ in., which will exclude very few objectives. It may, of course, be used, as the other, either in Microscopes with fixed stage tubes, or with movable substage.

**Paraboloid as an Illuminator for Homogeneous-Immersion Objectives.***—A. J. Moore attempts "to make two comparatively inexpensive pieces of apparatus take the place and do the work of any first-class wide-angled immersion condenser. These accessories are the ordinary parabola and the hemispherical lens."

Ordinarily the former is a dark-ground illuminator, but when the aperture of the objective exceeds that of the parabola, the effect is simply that of a dry condenser, in which the central rays are stopped out. But even at its best the light cannot traverse the slide at a greater angle than 41° from the axis; and it is rarely, if ever, even so great as this. Now, if the light reflected by the parabola could be converted into a glass (or balsam) angle without altering its angular direction, it would be amply sufficient to give light to the objective at the widest balsam angle now used in the best homogeneous-immersion objectives. This may be done by using, under the slide, a hemispherical lens,† whose radius is less than that of the concavity of the parabola, making optical contact by the immersion fluid. This is to be accurately centered and the parabola brought up so close that the hemispherical lens will occupy the concavity. When properly adjusted, it will be obvious that those rays which are transmitted by the parabola impinge normally to the surface of the hemispherical lens, and hence are not refracted; that is, they traverse the same path in the lens that they had upon the parabola. The effect, then, is that of the wide-angled immersion condenser with the central rays stopped out.

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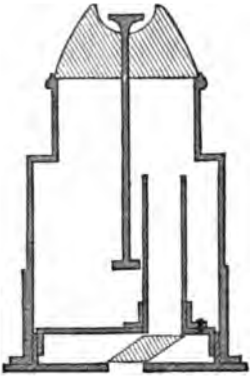
* 'The Microscope,' iv. (1884) pp. 27–30 (1 fig.).

† This was described and figured by Mr. F. H. Wenham, Trans. Micr. Soc. Lond., iv. (1856) pp. 57–8 (1 fig.).—Ed.

Although this may be very desirable for some objects, it is not generally so, and it becomes necessary to limit the direction from which the light comes. This may be very easily accomplished by the use of a cardboard diaphragm. This may be made by cutting a circle of blackened cardboard, the diameter of the inside of the mounting of the parabola, so that when pushed home against the glass surface the circle will be held friction-tight. By cutting small holes in this card the light may be regulated; and it should be kept well in mind that when the holes are cut in the outer edge of the card, the light, although oblique, will be more nearly central than when admitted to the reflecting surface through a hole nearer the centre; but should the hole be too near the centre of the card the light will not be transmitted at all, owing to the fact that it will strike the top of the concavity of the parabola. A good guide to go by is a circle upon the card whose diameter is the same as that of the top of the concavity. The most of the oblique light may then be obtained by cutting the holes near this line. Holes may be cut at various angles to each other, to effect the resolution of the various sets of lines by which some objects are marked.

The author adds: "The chief objection to this method of illumination is, that central light cannot be obtained; but this, of itself, is of no particular account, as the parabola may be removed from the substage when it is desired. As to the performance of this arrangement, I can speak in the highest terms; the resolution of the diatoms of Möller's balsamed plate being easily accomplished; and when the full operation of the parabola was used, the dots of No. 18 showed better than I have ever seen them by any other method of illumination."

FIG. 63.



**Paraboloid for Rotating Illumination in Azimuth.**—We have a paraboloid with an arrangement shown in section in fig. 63. The bottom of the fitting is closed by a brass box in which is a rhomboidal prism, the lower face of which is over an oblong slot in the centre of the lower plate of the box, while the upper face is towards the side of the upper plate, and just beneath the outer zone of the paraboloid. Over the upper face is a tube 1½ in. high (the horizontal section of which is shown in fig. 64). Axial rays are, by means of the prism, made to fall on a part of the outer zone of the paraboloid, and by rotating the box can be brought into any azimuth of the latter.

FIG. 64.

**Horizontal Position of the Microscope.**[*]—Mr. H. J. Slack considers that the usual position of a Microscope with a tube slanting a little and the head leaning forward to look down it, is all very well for a short examination of any object, but not at all desirable for continuous work. A better plan is to get a carpenter to make a light stool 2 ft. long and 14 in. wide, standing on four legs, the length of which should be determined by that of the Microscope it is intended to use and the height at which the observer sits. His own stool is 7 in. high, and when placed on an ordinary table brings a full-sized Microscope with its tube in a horizontal position at a convenient height for the eye of an observer sitting in an ordinary chair. The late Mr. Lobb, who was skilful in exhibiting troublesome objects, always used his Microscope in this position; but as far as Mr. Slack knows, it is seldom adopted. When the instrument is in position as described, the substage mirror should be turned out of the way, and the lamp placed so that its flame is exactly opposite the axis of the instrument, and can be seen in the middle of the field on looking through it. If the objects to be watched are large enough for a low power, the light may be softened by placing under the slide a piece of foreign post paper saturated with spermaceti. For high powers, an achromatic condenser is desirable, and one of the smallest central stops is usually the most useful for displaying fine cilia, or delicate whips, as well as for lighting up without glare the interior of various creatures. If all is arranged properly, the manners and customs of infusoria may be watched for hours without more fatigue than reading a well-printed book. A tenth part of the time spent with the head leaning forward in the usual way is far more exhausting.

**Flögel's Dark Box.**—Dr. J. H. L. Flögel some fourteen years ago devised the dark box, shown in fig. 65, to put over the Microscope and shut out all extraneous light. It is open behind and has an aperture in front to admit light to the mirror. From back to front it measures 20–25 cm., and in width 60–80 cm.; its height depends upon the stand to be used.[†] He now adds a few words in the interest of those microscopists who may wish to have similar boxes made.[‡]

The principal thing is the right position of the aperture by which the light is admitted; its upper edge must lie exactly at the level of the stage—not lower, in order that the full light from the window may be used; and not higher, in order that light may not fall from above on the stage, which would do away with most of the advantages of the box. The Microscope is put as far as possible in the box, so that the edge of the stage touches it, and, in order that there may be sufficient room for the head of the observer in this position, the anterior portion of the box is bowed out. On the right and left of the

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[*] 'Knowledge,' v. (1884) pp. 109–10.

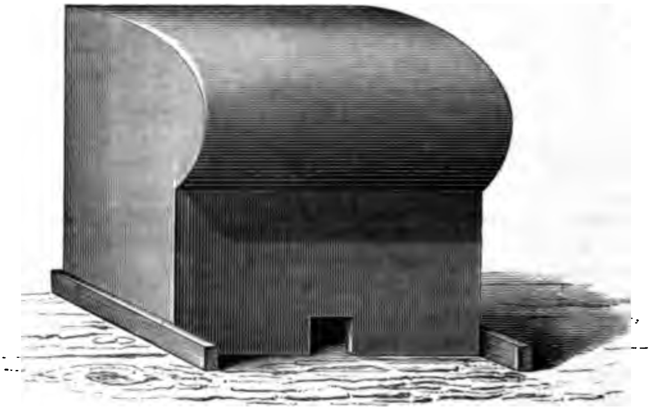
[†] Dr. L. Dippel considers this plan preferable to a darkened room with an opening in the shutter to admit light. The contrast between the illuminated field and the dark room is too great. The pupil of the eye is now enlarging and now contracting, and injurious results must inevitably follow. 'Das Mikroskop,' 1882, pp. 751–2 (1 fig.).

[‡] Zool. Anzeig., vi. (1883) pp. 566–7.

Microscope there should be enough room for the hands to move comfortably and to be able to draw.

The action of the dark box is that it strengthens the retina wonderfully in the perception of the finest details. This takes place in two ways. First, in the ordinary mode of observing with the Microscope, the eye of the observer is so much disturbed by the light from the illuminated eye-piece setting, and the surrounding objects, that many microscopists are accustomed to shade the eye with the hollowed hand as a remedy in delicate observation. This is obviated in the most perfect manner by the dark box. In the next place, it is by no means a matter of indifference whether strong or weak light-impressions are simultaneously received by the other open eye, which is at rest. Every more intense light-impression prejudices the sight of the other eye more than is commonly supposed. Into the dark box, however, only a faint illumination can enter from the light of the room behind it, especially when the table is black.

FIG. 65.



**Feussner's Polarizing Prism.***—Dr. K. Feussner gives a detailed description of the polarizing prism lately devised by him, which presents several points of novelty, and for which certain advantages are claimed. The paper also contains an account, although not an exhaustive one, of the various polarizing prisms which have from time to time been constructed by means of different combinations of Iceland spar.

I. *Older Forms of Polarizing Prisms.*—In comparing the various forms of polarizing prisms, the main points which need attention are:—the angular extent of the field of view; the direction of the emergent polarized ray, whether it is shifted to one side of or remains symmetrical to the long axis of the prism; the proportion which the length of the prism bears to its breadth; and, lastly, the position of the terminal faces, whether perpendicular or inclined to the long axis. These requirements are fulfilled in different degrees by the following methods of construction.

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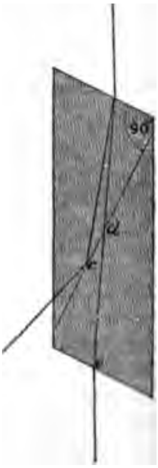
* Zeitschr. f. Instrumentenk., iv. (1884) pp. 42–50 (8 figs.). See P. R. Sleeman in 'Nature,' xxix. (1884) pp. 514–7 (8 figs.).

1. *The Nicol Prism.**—This (fig. 66), as is well known, is constructed from a rhombohedron of Iceland spar, the length of which must be fully three times as great as the width. The end faces are cut off in such a manner that the angle of 72° which they originally form with the lateral edge of the rhombohedron, is reduced to 68°. The prism is then cut in two in a plane perpendicular to the new end surfaces, the section being carried obliquely from one obtuse corner of the prism to the other, in the direction of its length. The surfaces of this section, after having been carefully polished, are cemented together again by means of Canada balsam. A ray of light, on entering the prism, is separated by the double refraction of the calc-spar into an ordinary and an extraordinary ray: the former undergoes total reflection at the layer of balsam at an incidence which allows the extraordinary ray to be transmitted; the latter, therefore, passes through unchanged. This principle of obtaining a single polarized ray by means of total reflection of the other is common to all the forms of prism now to be described.

FIG. 66.



Dr. Feussner gives a mathematical analysis of the paths taken by the two polarized rays within the Nicol prism, and finds that the emergent extraordinary ray can include an angular field of 29°, but that this extreme value holds good only for rays incident upon that portion of the end surface which is near to the obtuse corner, and that from thence it gradually decreases until the field includes an angle of only about half the previous amount. He finds, moreover, that, although of course the ray emerges parallel to its direction of incidence, yet that the zone of polarized light is shifted to one side of the central line. Also that the great length of the Nicol—3·28 times its breadth—is not only an inconvenience, but, owing to the large pieces of spar thus required for its construction, prisms of any but small size become very expensive. To this it may be added that there is a considerable loss of light by reflection from the first surface, owing to its inclined position in regard to the long axis of the prism.

It is with the view of obviating these defects that the modifications represented in figs. 67 to 71 have been devised.

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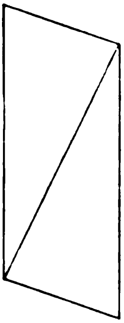
* Edin. New Phil. Journal, vi. (1828) p. 83.

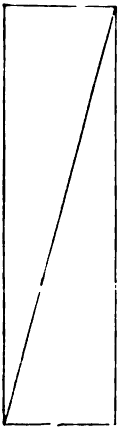
2. *The Shortened Nicol Prism* (fig. 67).—This arrangement of the Nicol prism is constructed by Steeg and Reuter of Homburg v. d. H. For the sake of facility of manufacture, the end surfaces are cleavage planes, and the oblique cut, instead of being perpendicular, makes with these an angle of about 84°. By this alteration the prism becomes shorter, and is now only 2·83 times its breadth; but if Canada balsam is still used as the cement, the field will occupy a very unsymmetrical position in regard to the long axis. If balsam of copaiba is made use of, the index of refraction of which is 1·50, a symmetrical field of about 24° will be obtained. A prism of this kind has also been designed by B. Hasert, of Eisenach,[*] but its performance appears to be inferior to the above.

FIG. 67.



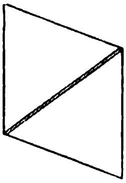
3. *The Nicol Prism with Perpendicular Ends* (fig. 68).—The terminal surfaces in this prism are perpendicular to the long axis, and the sectional cut makes with them an angle of about 75°. The length of the prism is 3·75 times its breadth, and if the cement has an index of refraction of 1·525, the field is symmetrically disposed, and includes an angle of 27°. Prisms of this kind have been manufactured by Steeg, C. D. Ahrens, and others.

FIG. 68.



4. *The Foucault Prism* [†] (fig. 69).—This construction differs from all those hitherto mentioned, in that a film of air is employed between the two cut surfaces as the totally reflecting medium instead of a layer of cement. The two halves of the prism are kept in position, without touching each other, by means of the mounting. The length of the prism is in this way much reduced, and amounts to only 1·528 times its breadth. The end surfaces are cleavage planes, and the sectional cut makes with them an angle of 59°. The field, however, includes not more than about 8°, so that this prism can be used only in the case of nearly parallel rays; and in addition to this the pictures which may be seen through it are to some extent veiled and indistinct owing to repeated internal reflection.

FIG. 69.



5. *The Hartnack Prism* [†] (fig. 70).—This form of prism was devised in 1866 by Hartnack and Prazmowski, and was described, vol. iii. (1883) p. 428. It is considered by Dr. Feussner to be the most perfect prism capable of being prepared from calcspar. The ends of the prism are perpendicular to its length; the

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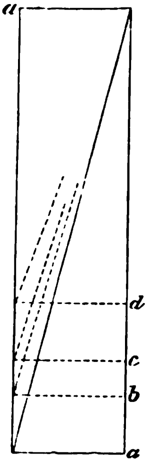
[*] Pogg. Ann., cxiii. p. 189.

[†] Comptes Rendus, xlv. (1857) p. 238.

[‡] Ann. Chem. et Physique, vii. (1866) p. 181.

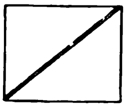
section carried through it is in a plane perpendicular to the principal axis of the crystal. The cementing medium is linseed oil, the index of refraction of which is 1·485. The field of view afforded by this construction depends upon the cementing substance used, and also upon the inclination of the sectional cut in regard to the ends of the prism; it may vary from 20° to 41°. If the utmost extent of the field is not required, the prism may be shortened by lessening the angle of the section at the expense however of interfering with the symmetrical disposition of the field.

FIG. 70.



6. *The Glan Prism*[*] (fig. 71).—This is a modification of the Foucault, and in similar manner includes a film of air between the sectional surfaces. The end surfaces and also the cut carried through the prism are parallel to the principal axis of the calc-spar. The ends are normal to the length, and the field includes about 8°. This prism is very short, and may indeed be even shorter than it is broad. It is subject to the same defect as that mentioned in the case of the Foucault, although perhaps not quite to the same extent.[†]

FIG. 71.



II.—*Feussner's Prism* (figs. 72–3).—This prism differs very considerably from the preceding forms, and consists of a thin plate of a doubly refracting crystal cemented between two wedge-shaped pieces of glass, the terminal faces of which are normal to the length. The external form of the prism may thus be similar to the Hartnack, the calc-spar being replaced by glass. The indices of refraction of the glass and of the cementing medium should correspond with the greater index of refraction of the crystal, and the direction of greatest and least elasticity in the latter must stand in a plane perpendicular to the direction of the section. One of the advantages claimed for the new prism is that it dispenses with the large and valuable pieces of spar hitherto found necessary: a further advantage being that other crystalline substances may be used in this prism instead of calc-spar. The latter advantage, however, occurs only when the difference between the indices of refraction for the ordinary and extraordinary rays in the particular crystal made use of is greater than in calc-spar. When this is the case, the field becomes enlarged, and the length of the prism is reduced.

The substance which Dr. Feussner has employed as being most suitable for the separating crystal plate is nitrate of soda (*natron-salpeter*), in which the above-mentioned values are $\omega = 1 \cdot 587$ and

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[*] Carl's 'Repertorium,' xvi. p. 570 and xvii. p. 195.

[†] Amongst others, the modifications of the Nicol prism which have recently been devised by Prof. S. P. Thompson (see this Journal, iii. (1883) p. 575), and by Mr. R. T. Glazebrook (Phil. Mag., 1883, p. 352), do not appear to have been known to Dr. Feussner.

$\epsilon = 1\cdot 336$. It crystallizes in similar form to calcite, and in both cases thin plates obtained by cleavage may be used.

As the cementing substance for the nitrate of soda, a mixture of gum dammar with monobromonaphthalene was used, which afforded an index of refraction of 1·58. In the case of thin plates of calcite, a solid cementing substance of sufficiently high refractive power was not available, and a fluid medium was therefore employed. For this purpose the whole prism was inclosed in a short glass tube with air-tight ends, which was filled with monobromonaphthalene. In an experimental prism a mixture of balsam of tolu was made use of, giving a cement with an index of refraction of 1·62, but the low refractive power* resulted in very considerable reduction of the field. The extent and disposition of the field may be varied by altering the inclination at which the crystal lamina is inserted (fig. 72), and thereby reducing the length of the prism, as in the case of the Hartnack.

Fig. 72.

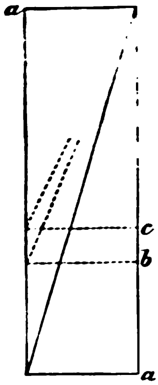
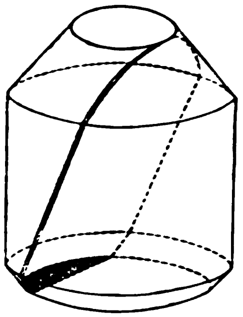


Fig. 73.



In order to obviate the effects of reflection from the internal side surfaces of the prism, the wedge-shaped blocks of glass of which it is built up may be made much broader than would otherwise be necessary; the edges of this extra width are cut obliquely, and suitably blackened.

The accompanying diagram (fig. 73) represents a prism of cylindrical external form constructed in this manner, the lower surface being that of the incident light. In this the field amounts to 30°, and the breadth is about double the length.

Dr. Feussner remarks that a prism similar in some respects to his new arrangement was devised in 1869 by M. Jamin,† who used a thin plate of calc-spar inclosed in a cell filled with bisulphide of carbon; and also by Dr. Zenker, who replaced the liquid in M. Jamin's construction by wedges of flint glass.

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* i. e. low as against 1·6585 the greater index of the calc-spar.

† Comptes Rendus, lxviii. (1869) p. 221.

The following tabular view of different forms of polarizing prisms is taken from the conclusion of Dr. Feussner's paper:—

| | Field. | Inclination of section in regard to long axis. | Ratio of length to clear width. | Fig. |
|---|---|---|---|---|
| | ° | ° | | |
| I. THE OLD POLARIZING PRISMS. | | | | |
| 1. Nicol's prism .. .. .. .. .. .. | 29 | 22 | 3·28 | 66 |
| 2. Shortened Nicol prism. | | | | |
| *a.* Cemented with Canada balsam | 13 | 25 | 2·83 | 67 |
| *b.* „ „ copaiba „ | 24 | 25 | 2·83 | 67 |
| 3. Nicol with perpendicular ends. | | | | |
| *a.* With Canada balsam.. .. .. | 20 | 15 | 3·73 | 68 |
| *b.* With cement of index of refraction of 1·525 .. .. .. .. | 27 | 15 | 3·73 | 68 |
| 4. Foucalt's prism .. .. .. .. | 8 | 40 | 1·528 | 69 |
| 5. Hartnack's prism. | | | | |
| *a.* Original form .. .. .. .. | 35 | 15·9 | 3·51 | 70 *a b* |
| *b.* With largest field .. .. .. | 41·9 | 13·9 | 4·04 | 70 *a a* |
| *c.* With field of 30° .. .. .. | 30 | 17·4 | 3·19 | 70 *a c* |
| *d.* With field of 20° .. .. .. | 20 | 20·3 | 2·70 | 70 *a d* |
| 6. Glan's prism .. .. .. .. .. .. | 7·9 | 50·3 | 0·831 | 71 |
| II. FEUSSNER'S POLARIZING PRISM. | | | | |
| 1. With calc-spar: largest field .. | 44 | 13·2 | 4·26 | 70 *a a* |
| 2. „ „ field of 30° .. | 30 | 17·4 | 3·19 | 70 *a c* |
| 3. „ „ field of 20° .. | 20 | 20·3 | 2·70 | 70 *a d* |
| 4. With nitrate of soda: largest field | 54 | 16·7 | 3·53 | 72 *a a* |
| 5. „ „ „ field of 30° | 30 | 24 | 2·25 | 72*ab* & 73 |
| 6. „ „ „ field of 20° | 20 | 27 | 1·96 | 72 *a c* |

As an analysing prism of about 6 mm. clear width, and 13·5 mm. long, the new prism is stated by its inventor to be of the most essential service, and it would certainly appear that the arrangement is rather better adapted for small prisms than for those of considerable size. Any means by which a beam of polarized light of large diameter—say 3 to 3½ in.—could be obtained with all the convenience of a Nicol would be a real advance, for spar of sufficient size and purity for such a purpose has become so scarce, and therefore so valuable, that large prisms are difficult to procure at all. So far as an analyser is concerned, the experience of Mr. P. R. Sleeman would lead to the opinion that improvements are to be looked for rather in the way of the discovery of an artificial crystal which absorbs one of the polarized rays than by further modifications depending upon total reflection. The researches of Dr. Herapath on iodosulphate of quinine* are in this direction; but crystals of the so-called herapathite require great manipulative skill for their production. If these could be readily obtained of sufficient size, they would be invaluable as analysers.

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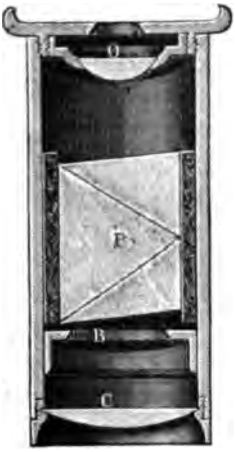
* Phil. Mag., 1852, p. 161, and 1853, p. 346.

This opinion is supported by the existence of an inconvenience which attends every form of analysing prism. It is frequently, and especially in projecting apparatus, required to be placed at the focus of a system of lenses, so that the rays may cross in the interior of the prism. This is an unfavourable position for a prismatic analyser, and in the case of a powerful beam of light, such as that from the electric arc, the crossing of the rays within the prism is not unattended with danger to the cementing substance, and to the surfaces in contact with it.

FIG. 74.



**Abbe's Analysing Eye-piece.**—This (fig. 74), devised by Prof. Abbe, consists of a Huyghenian eye-piece with a doubly refracting prism P (a calc-spar prism achromatized by two suitable glass prisms) inserted between the eye-lens O and field-lens C, and over the diaphragm at B. The rays polarized parallel to the refracting edge pass through the prisms without deviation, whilst those polarized at right angles are strongly deflected, and are stopped off by a diaphragm over the eye-lens. The field of view remains undiminished.

**Measurement of the Curvature of Lenses.***—With very small lenses the spherometer cannot be used, and Prof. R. B. Clifton's method is based on the Newton's rings formed between the lens and a plane surface, or a curved surface of known radius. From the wave-length of the light employed in observing and the diameter of a ring the radius of curvature can be determined. He places the lens on a plane or curved surface under a Microscope, and lights it by the sodium flame —wave-length $5892 \times 10^{-7}$—measures the approximate diameters of two rings a distance apart (in practice the tenth and twentieth rings are found convenient), takes the difference of their squares, and divides it by the wave-length and the number of rings in the gap between to find the radius of the lens. The formula is :—

$$\rho^1 \, m \, \lambda = (x^2{}_{m+n} - x^2{}_n)$$

where $x_m + {}_n$ and $x_n$ are the diameters of the $n$th and $(m + n)$th rings ; $\lambda$ is the wave-length of the light, and $\rho^1$ the radius of curvature of the lens. The method with proper care gives accurate results. Prof. Clifton has also used it to determine the refractive index of liquids in small quantities; Mr. Richardson having found it for water = 1·3335 by this method, which is usually correct to two places of decimals. It can also be used to determine if the lens is uniformly curved and spherical.

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* 'Nature,' xxix. (1883) p. 143.

**New Microscopical Journals.**—Two new Journals have made their appearance. The first is the quarterly 'Zeitschrift für wissenschaftliche Mikroskopie und für mikroskopische Technik,' published at Brunswick, and edited by Drs. L. Dippel, M. Flesch, A. Wichmann, and W. J. Behrens. It embraces "Microscopy" in its widest sense, and includes original articles, abstracts and reviews, and a bibliography of microscopical literature. It may be recommended to all microscopists who read German. The other is the bi-monthly 'Microscopical Bulletin,' published by Queen and Co., of Philadelphia, which, though unpretentious, gives useful information on microscopical subjects.

Bausch, E.—A new Condenser. [*Post.*] *The Microscope*, IV. (1884) pp. 105–6.
„ „ Eye-pieces and Objectives.
[General explanations.] *The Microscope*, IV. (1884) pp. 107–12.

Bausch and Lomb Optical Co.'s Improved "Investigator" Stand.
[Cf. I. (1881) p. 100. Mirror and substage now swing independently, position of body-rack changed, &c.]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 84 (1 fig.).

Bohn, C.—Ueber die Berichtigung des vereinfachten Ablese-Mikroskopes für Theilungen. (On the rectification of the simplified reading Microscopes for graduations. [*Supra*, p. 436.]
*Zeitschr. f. Instrumentenk.*, IV. (1884) pp. 87–8.

Bond, G. M.—Standards of Length and their Subdivision.
[Describes the Saxton Yard-dividing Comparator, the Rogers-Bond Universal Comparator, and a Comparator made by the Ballon Manufacturing Company for Professor Anthony.]
*Journ. Franklin Institute*, CXVII. (1884) pp. 281–95, 357–67 (5 figs.).

Bradbury, W.—The Achromatic Object-glass. XXXII.-V.
*Engl. Mech.*, XXXIX. (1884) pp. 93–4, 159–60, 246–7, 272 (6 figs.).

"Calculus."—Polarizer for the Microscope.
[Simple contrivance to fit on tail-piece.]
*Engl. Mech.*, XXXIX. (1884) p. 215 (1 fig.).

Congdon, E. A.—Microscopy one hundred and fifty years ago.
[Notes on 'Baker on the Microscope,' 1740.]
*The Microscope*, IV. (1884) pp. 74–6.

D., E. T.—Graphic Microscopy.
IV. Pollen of Mallow. V. Peristome of *Fumaria hygrometrica*.
*Sci.-Gossip*, 1884, pp. 73–4 (1 pl.), 97–8 (1 pl.).

Davis, G. E.—[Leitz's] Oil-immersion Objectives.
*Micr. News*, IV. (1884) pp. 131–2.
„ „ Evenings with the Microscope. I.
[Measuring magnifying power of objectives and eye-pieces, and testing corrections of objectives.]
*Micr. News*, IV. (1884) pp. 132–5.
„ „ Microscopy. *Sci. Monthly*, I. (1883) p. 26.

**Fleisch, M.**—Welche Aussichten bietet die Einführung des elektrischen Lichtes in die Mikroskopie? (What prospect does the introduction of the electric light afford in Microscopy?) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 175–81.

**Hansen, E. C.**—Ueber das Zählen mikroskopischer Gegenstände in der Botanik. (On the counting of microscopic objects in Botany.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 191–210 (6 figs.).

**Hazlewood, F. T.**—A home-made revolving Table. [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 94.

**Hitchcock, R.**—Neglected Opportunities.
[Exhortation to investigate the microscopic life of the country.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 95–6.

„ „ A New Microscopical Society.
[Sarcastic comment on the announcement of the establishment of the Ladies' Microscopical Society at San Francisco having been first sent to England. "Trusting the members will learn that, although they may look to foreign lands for styles and methods of personal adornment, when they come to such a serious subject as microscopy, their wants can be as well met and their fame as well appreciated in their own country."]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 97.

**Jadanza, N.**—Sui sistemi diottrici compositi. (On compound dioptric systems.)
*Atti R. Accad. Sci. Torino*, XIX. (1883) pp. 99–117.

**Jung, H.**—Ueber ein neues Compressorium. (On a new Compressor.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 248–50 (2 figs.).

**Lancaster, W. J.**—Lantern Microscope.
[Directions for making. "You may make a lantern Microscope in half a dozen different ways, and the method to work upon will depend entirely upon the illumination you have. You state in query that you have the lime-light; you could not have anything better. Fit up your Microscope in any form you like, and for object-lenses get three sets of lenses, A, two 1½ in. focus, both plano, one 1/2 in., the other 3/4 in. diameter; B, two lenses both 1 in. focus, one 3/8 in. diameter, the other 5/8 in. diameter; C, two lenses 3/4 in. focus, one 1/4 in., the other 1/2 in. diameter; and D, two lenses 1/2 in. focus, one 3/16 in., the other 3/8 in. diameter. Mount them in separate tubes in each case, both convex surfaces together, at the following distances apart:—A 1 in., B 2/3 in., C 1/2 in., D 5/16 in.; then a stop must be placed in front of each of the smallest lenses, the larger lens going towards object. The sizes of stops and their distances from small lenses are as follows:—A, 1/8 in. diameter, 1/2 in. in front; B, 3/32 in., 5/16 in.; C., 1/12 in., 3/16 in.; D, 1/16 in., 1/8 in."]
*Engl. Mech.*, XXXIX. (1884) p. 152.

**Lommel, E.**—Spectroskop mit phosphorescirendem Ocular. (Spectroscope with phosphorescent eye-piece.) [*Post.*]
*SB. K. Akad. Wiss. München*, 1883, p. 408.

Magnifying Powers, Table of, with Note. *Micr. Bulletin*, I. (1884) p. 23.

**McCalla, A.**—The "Congress" Nose-piece.
[Reply to Mr. Bulloch, *ante*, p. 300, with woodcuts of his original design.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 64–5 (3 figs.), 78–9.
*The Microscope*, IV. (1884) pp. 101–2.

**Mercer, F. W.**—A New Photomicrographic Camera. [*Post.*]
*Photography* (Chicago), I. (1884) pp. 9–10 (1 fig.).

**Mitchell, G. O.**—A Focusing Glass for Photo-micrography. [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 80 (1 fig.).

**Nelson, E. M.**—On the selection and use of Microscopical Apparatus.
[*Ante*, p. 302, repeated here to give the following note:—(1) The Ross is decidedly to be preferred to the Jackson form, mainly on the ground of

the superiority of the long lever fine-adjustment over any other. (2) No Microscope is worthy to be called a scientific instrument unless it has a centering substage. (3) Choice and Aperture of Objectives, *supra*, p. 447. (4) Eye-pieces. (5) Daylight, artificial light, and incandescence lamp, *supra*, p. 447. (6) Condensers (Powell's the most effective for powers beyond 1/4). (7) Paraboloids, Lieberkuhns (*post*), Vertical Illuminator, and Micrometers. (8) Polarization. (9) Diffraction and the difficulties of interpretation with objects requiring high magnification.]

*Engl. Mech.*, XXXIX. (1884) p. 48.

**Noe, L. H.**—Homogeneous immersion.

["It seems to me that to make a lens which shall work through different thicknesses of cover-glass equally well and without adjustment, the immersion medium should correspond with the cover-glass, so that the combined thickness of glass and immersion fluid would always be the same (although the thickness of each varied) for an object in contact with the under side of the cover."]

*Amer. Mon. Micr. Journ.*, V. (1884) p. 79.

"**Not an Optician.**"—Theory of the Achromatic Object-glass.

[Comments on O. V.'s articles.]

*Eng. Mech.*, XXXIX. (1884) p. 210.

"**Orderic Vital.**"—The Dialyte and Plate Glass.

*Engl. Mech.*, XXXIX. (1884) p. 215.

**Orth, J.**—Cursus der normalen Histologie zur Einführung in den Gebrauch des Mikroskopes sowie in das practische Studium der Gewerbelehre. (Course of normal Histology as an introduction to the use of the Microscope as well as to the practical study of Histology.) 3rd ed., xii. and 340 pp., 108 figs. 8vo, Berlin, 1884.

**Peaucellier.**—Note sur la déformation des images réfractées et sur l'aplanatisme d'un système de lentilles. (Note on the distortion of refracted images and on the aplanatism of a system of lenses.)

*Mém. Soc. Sci. Bordeaux*, V. (1883) pp. 327–34 (1 pl.).

**Peragallo, H.**—Histoire sommaire du Microscope composé et de ses récents perfectionnements. (Compendious history of the compound Microscope and its recent improvements.) 8vo, Toulouse, 1883.

**Plehn, F.**—Apparat zur Prüfung der Brennweite des Auges oder anderer optischer Systeme. (Apparatus for testing the focal length of the eye or other optical systems.)

Title only of German Patent, Cl. 42, No. 1894, Feb. 1884.

"**Prismatique.**"—Plate Glass for Optical Purposes.

*Engl. Mech.*, XXXIX. (1884) pp. 191–2, 281.

**Proctor, R. A.**—Review of Poulsen and Trelease's 'Botanical Micro-chemistry,' in which the invention of the achromatic microscope-objective is attributed to J. J. Lister in 1829! *Knowledge*, V. (1884) p. 231.

**Puscher & Wiederhold.**—Cementing Brass on Glass.

[Puscher recommends a resin soap for this purpose, made by boiling 1 part of caustic soda, 3 parts of colophonium (resin) in 5 parts of water and kneading into it half the quantity of plaster of Paris. This cement is useful for fastening the brass tops on glass lamps, as it is very strong, is not acted upon by petroleum, bears heat very well, and hardens in one-half or three-quarters of an hour. By substituting zinc white, white lead, or air-slaked lime for plaster of Paris, it hardens more slowly. Water only attacks the surface of this cement. Wiederhold recommends, for the same purpose, a fusible metal composed of 4 parts of lead, 2 parts tin, and 2½ parts bismuth, which melts at 212° Fahr. The melted metal is poured into the capsule, the glass pressed into it and then allowed to cool slowly in a warm place.]

*Polyt. Notizblatt.* See *Engl. Mech.*, XXXIX. (1884) p. 119.

**Reichert, C.**—Anleitung zum Gebrauche des Mikroskops. (Introduction to the use of the Microscope.) 14 pp. (2 figs.), 8vo, Wien, 1883.

Scott, G. B.—Polarizer for the Microscópe.
[Analyser mounted in a tube on a swivel just over the nose-piece so that it can be "pushed over to one side out of the way by a lever" when not in use. Polarizer also mounted on a short arm beneath the stage. Microscopes with narrow tubes must have a recess into which the analyser can go.]
*Engl. Mech.*, XXXIX. (1884) p. 173 (2 figs.).

Stein, T.—Die Verwendung des elektrischen Glühlichtes zu mikroskopischen Untersuchungen und mikrophotographischen Darstellungen. (The application of the electric incandescence light for microscopical investigations and photomicrography.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 161–74 (7 figs.).

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" " An Editor's Life.
[Letter from a microscopist who "finds the working of the Microscope very pleasant employment for the evening of life."]
*The Microscope*, IV. (1884) p. 105.

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*Journ. of Sci.*, VI. (1884) pp. 198–206.

Tait, P. G.—Light. viii. and 276 pp. and 49 figs. [Microscope, pp. 113–6.] 8vo, Edinburgh, 1884.

Vogel, J.—Das Mikroskop und die wissenschaftliche Methode der mikroskopischen Untersuchung in ihrer verschiedener Anwendung. 4th ed. By O. Zacharias. Lfg. 1. Leipzig, 1884.

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Ward, R. H.—An Eye-shade for Monocular Microscopes. [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 82–3 (1 fig.).

Wassell, H. A.—Plate Glass for Optical Purposes.
*Engl. Mech.*, XXXIX. (1884) pp. 170–1.

Wiederhold.—See Puscher.

Zacharias, O.—See Vogel, J.

## β. Collecting, Mounting and Examining Objects, &c.

**Dissection of Aphides.***—G. B. Buckton says that "in the dissection of Aphides much assistance may be often got by a selection of liquids. Some of these are best suited for the purpose of hardening the tissues, so that they may bear separation and tearing asunder without their destruction. Others are used for colouring the transparent organs, so as to make them more visible. These organs of Aphides are so delicate that pure water will in a great measure destroy them. In such cases a weak solution of common salt, or very dilute glycerine, or sugar and water, or albumen and water, all of which should nearly approach the density of the juices of the insect, will be found a considerable help.

Some Aphides are so large, so full of liquid, and so charged with oil-globules that some treatment is necessary to reduce their bulk, and to allow of a sufficiently thin stratum of balsam for mounting.

In such cases the Aphides may be placed in spirits of turpentine, and just raised to the boiling-point in a small test-tube. After soaking in the turpentine for a few hours, all the oil-globules will be removed, and the insect by this treatment will have become transparent, and the aqueous parts will not then chill the balsam.

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* 'Monograph of the British Aphides,' iv. (1883) pp. 193–5.

To prepare Aphides for dissection, liquids may be divided into those used for hardening the tissues and those employed for colouring the same. For hardening, a digestion for several hours in weak alcohol will be of advantage. The alcohol must not be too strong, or the albuminous portions will be coagulated and become too opaque.

Weak acetic acid will render some portions tough, and the same action is also well effected by a weak solution of phosphoric or of nitric acid.

The action of ordinary ether upon Aphides is not well understood. Their bodies are speedily destroyed by plunging them into the liquid. At the same time a considerable stream of air-bubbles contained in the tracheæ is expelled, and of such a volume as would lead to the supposition that much of this air must be in some state of solution in the body-juices.

The reaction of weak potash has been before noted. As a rule, the germinal matter resists its action for a considerable time. Simultaneously this reagent usually stains it a bright gamboge yellow. In some genera (notably *Sachuus* and *Dryobius*) potash deepens very markedly the violet dye natural to these Aphides. In other cases I have found potash to evoke the violet shade from specimens otherwise colourless. This dye is fugitive, and if discharged by an acid, cannot be again recovered by the action of an alkali. Soda and ammonia also bring out this colour.

Advantage may be taken of the fact that there is a certain order in which the tissues resist the intrusion of a foreign matter such as a dye. Thus the germinal and most vitally endowed organs reject dyeing by carmine, logwood, and such coal-colours as magenta; whilst the portions in process of exfoliation and decay absorb it the most readily. For such purposes, weak alcohol may be made slightly alkaline by ammonia, and tinged with a little carmine or cochineal solution. Dilute chromic acid both tinges the tissues yellow and renders them tough. Solutions of osmic acid also may be used with advantage, and, in short, the usual reagents employed for conducting minute anatomy may be taken with due circumspection and tenderness.

For labelling specimens, paste will be found much more adherent than gum. The former may be preserved for some months in a well-closed bottle, if a little aqueous solution of corrosive sublimate be stirred into it."

**Transmission, Preservation, and Mounting of Aphides.***—G. B. Buckton gives the results of his experience as to the best mode of transmitting living Aphides, and also the best method for killing and preserving such-like insects for future examination.

As to transmission, the chief thing to be guarded against is desiccation, and no plan seems to be so successful as their inclosure in ordinary quills stopped by plugs of cork or pellets of beeswax. The substance of the quill is sufficiently porous to prevent mildew on the one hand and a rapid evaporation on the other. In this way small insects may be sent through the post, and in a far better condition than can be secured in any tin boxes, even though they be filled with leaves. If a slip of some succulent leaf be rolled round each quill, to retain moisture, a bundle will conveniently pass through the post.

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* 'Monograph of the British Aphides,' iv. (1883) pp. 188–93.

For preservation (other than on a slide) the best plan is to drop the insects into small flattened glass tubes partially filled with a suitable liquid, then draw the tube to a fine point, break the end off, and warm the empty space (or, better, expel the air by a pump), and the tube can be entirely filled with liquid, and then sealed with the blowpipe.

For mounting microscopically, five or a dozen spots of fluid Canada balsam should be dotted on a slide from the head of a pin, and by means of a hair pencil as many living insects transferred to them. "The specimens at once adhere, and if the spots are small the insects spread out their limbs naturally, with a view to escape. They may be fixed on their backs or otherwise, according to the views desired.

A very thin glass cover, or, if very high magnifying powers are wanted, a small disk of clear mica, is laid over the insects, and then one or more drops of the fluid balsam are delivered from a glass rod at one of the sides of these covers. The balsam runs slowly under by capillarity, and it drives all the air before it, the small weight of the cover assisting it to spread, until the whole area is filled. No pressure is to be used, or the elastic bodies of the Aphides will change shape; and besides this, the juices will be forced through the cornicles and pores. If the balsam is thick, a very gentle heat, hardly exceeding that of the cheek, may be applied, but as a rule the temperature of a room is better than that which exceeds it. The insects die immediately they are cut off from air, and in almost every case their position will be good for examination. To spread the wings of a small insect, the above-mentioned small dots may be made in a row. The belly of the specimen is applied to the middle spot, and by a bristle one wing may be applied to the dot on the one side, and the other wing to the third dot. The cover is then placed as before, and when the balsam runs in it will not disturb the position of the spread wings.

It will be noticed that very soon after live insects have been mounted in a resinous substance that will not mix with water, a white cloudiness forms around each specimen. This is caused by the watery juices of the insect, which 'chill' the medium and make it opaque.

This cloudiness, however, entirely disappears after perhaps a month, the moisture being carried slowly outwards. The same is to be said of stray air-bubbles. The oxygen of the air unites with the balsam, and thus hardens it; but what combination is effected with the nitrogen is not so clear. However, air-bubbles in balsam disappear in time, provided the former is not in too hard a condition.

In cases when the above small pressure is undesirable, small circles, cut by round punches of different sizes out of very thin sheet lead, will be found more convenient to insert between the glass slip and its cover than circles of card, which are sometimes recommended. The thin sheet lead from the Chinese tea-chests is very suitable for punching, and as it is not porous like card, it yields no air-bubbles by heat.

D. Von Schlechtendal has* described a method by which it would appear that all the characters of form and colour (?) may be preserved in Aphides and other insects. The method consists of a rapid death and drying of the insect by means of a current of heated air. The *Aphis*, previously attached to some suitable support, is suddenly and momentarily subjected to the heat of a spirit or other flame, by which it is immediately killed and caused to retain its natural position. Several examples are then carefully roasted in a current of hot air, such as that passing through an inclined glass tube duly made hot, or dried on a sheet of paper moved over a heated metal plate.

When dry, the specimens are mounted on card by attachment with gum tragacanth; or, as Mr. T. W. Douglas suggests, more conveniently on mica, called 'talc,' in the shops, which, as it is incombustible, is well suited for a support both before and after drying.

This method is vouched for as good by Drs. Giebel, Taschenburg, Mayr, and Rudow.

I have not tried this roasting process, but it must require some address to prevent the shrivelling of wings in such delicately-formed insects, and to provide against the bursting action of the boiling juices.

A more complete history of the process than the foregoing was given by Mr. Douglas in 1878.†

M. Lichtenstein has many times been good enough to forward in letters to me preparations of Aphides which have been secured between two films of mica. The insects, he explains, are immersed in a solution of resin in turpentine, 'a natural amber,' and, when all are in due position, the mica films are placed over apertures in card, and then gummed papers, similarly perforated, are pressed upon them. This arrangement secures all in their places.

Methods and operations in science, like events in history, repeat themselves. Fifty years ago films of mica were used to cover objects for the Microscope, and before the manufacture of the thin glass now so commonly used, it admirably answered its purpose. Under deep magnifying powers, such as 1/12 in., it will be found even now of great service. The mineral may be split by the lancet into films much thinner than glass can be blown in a flat state. Small unscratched pieces may be selected which are perfectly transparent, and their cost is quite trifling.

On account of the high refracting power of Canada balsam, the colours of recently-immersed Aphides show themselves very brightly; and it sometimes happens that tints, quite lost through irradiation or glance on the surfaces, become distinct by treatment with this resin.

The bright colours and markings of some species are due to the hue of the internal juices of the insects. These cannot be preserved by balsam, but it is otherwise with the pigments which stain the somewhat horny coverings of the thorax and abdomen. These colours are persistent."

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* Entomol. Nachrich., iv. p. 155.

† Entomol. Mon. Mag., xv. p. 164.

**Breckenfeld's Method of Mounting Hydræ.***—A. H. Breckenfeld describes the following process as accomplishing the desired end more perfectly than any other published.

Have in readiness a slide upon which a well-dried cell of sufficient depth has been turned. Then, from a gathering of *Hydra*, transfer a sufficient number of individuals (the more fully developed the better) very carefully, by means of a camel's hair brush or a pipette, to a drop of water spread near the end of a plain glass slide, and place the latter upon a table in such a way that the end with the drop projects about two inches over the edge. This is easily done by placing a weight upon the opposite end. After allowing the slide to remain perfectly undisturbed for three or four minutes, hold a lighted coal-oil lamp so that the top of its chimney is very near the slide, but a trifle above it. The *Hydræ* will then appear brightly illuminated, and it can easily be determined by the unaided eye whether or not their tentacles are fully extended. If they are, quickly move the lamp directly under the drop, with the top of the chimney about an inch beneath the slide, and hold it in that position for about 3–5 seconds, the exact time depending principally upon the intensity of the heat. Then quickly remove the slide and place it upon a slab of marble or metal. When cool, pour the drop containing the zoophytes into the prepared cell on the slide which has been held in readiness, add a drop or two of a suitable preservative fluid, arrange the animals, if necessary, by means of a needle or camel's hair brush (using very great care, however, as the tentacles will be destroyed by the least rough handling), cover with thin glass, and finish as in the case of any fluid mount.

This "hot water" process seems to succeed peculiarly well with the brown *Hydra* (*H. vulgaris*).

**Cell-sap Crystals.**†—Crystals of the colouring material present in the petals and other portions of plants are by no means common or, as a rule, easy to obtain; and G. Pim thinks it may therefore interest some to know that the rich violet-coloured cell-sap in the flower of *Justicia speciosa*, a common and easily-grown stove-plant, crystallizes very easily into minute slender prisms. To obtain them it is only necessary to mount a fragment of the flower-stamen for choice, in dilute glycerine jelly, not too hot, without any previous treatment; after a few hours the colouring material collects into a few cells, in the form of the crystals above mentioned, forming a very pretty and interesting object for a 1/4 in. objective.

**Staining for Microscopic Purposes.**‡—H. Gierke contributes a paper on this subject. In the first part, after an excellent introduction, the writer gives an historical review of the application of micro-chemical methods of staining, giving special attention to the carmine-pigments. The earliest experiments on microscopic staining with carmine for the purpose of a ready differentiation of tissues were made by Goeppert and Cohn. More extended investigations on the capability of the various elements of vegetable tissues to fix carmine shortly followed by R. Hartig. In animal histology, carmine staining was first employed by Gerlach (1858). Further contributions to its application were made especially by Maschke, Thiersch, Beale, Rollen, Gwancher, Hoyer, Czokor, Ranvier, and others. Reference is further made to the cultivation of cochineal, and to the most convenient methods of obtaining carmine for technological purposes, and its application as a staining material in the form of ammonium carminate, and carmine acetate. The author convinced himself by experiments that old preparations of ammonium carminate, which contain a certain quantity of ammonium carbonate, stain better than fresh solutions. Finally, a shorter reference is made to the aniline-dyes, hæmatoxylin, indigo-carmine, and picro-carmine.

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* Amer. Mon. Micr. Journ., v. (1884) pp. 49-50.

† Journ. of Bot., xxii. (1884) p. 124.

‡ Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 62-100. See Bot. Centralbl., xviii. (1884) p. 52.

The second part includes a chronological and tabular account of the literature of the subject, especially with regard to the following staining materials:—(1) carmine; (2) hæmatoxylin; (3) ammonium molybdate; (4) alizarin and purpurin; (5) alcanna and lakmus; (6) sodium indigo-sulphate (indigo-carmine).

**Mode of announcing new Methods of Reaction and Staining.**[*]—E. Giltay calls attention to the fact that the publication of new methods of reaction is often made without sufficient precision for others to be able readily to form a judgment on their applicability for the special purpose. In the description of the application of a reagent, at least one mode of preparing it ought to be accurately described, such expressions as "somewhat," "a little," "a short time," and such like, should be avoided, and replaced by exact statements of weight and time. In the case of little known substances, the chemical formula—intelligible in all languages—should be appended. The descriptions of colours should be as correct as possible, with reference to all influencing circumstances, and should be based on some definite colour-scale, such as that of Chevreul's 'Des Couleurs.'

**Pure Carminic Acid for Staining.**[†]—G. Dimmock has often wondered why naturalists use carmine solutions in which water, with some caustic or destructive material added, is the principal solvent. Carmine of commerce, it is true, is not readily soluble, even in water, until ammonia, borax, or some other aid to solution is added; but carminic acid, the basis of the colouring matter of carmine, has long been stated in the leading chemical dictionaries and handbooks to be readily soluble in water and in alcohol. Watts (Dict. Chem., 1872, 1st suppl., p. 413) says of carminic acid:—"This acid forms a purple mass, fusible and soluble in all proportions in water and in alcohol. Sulphuric and hydrochloric acid dissolve it without alteration. It bears a heat of 136° C. without decomposition." Earlier still Watts (Dict. Chem., i. 1863, p. 804) says:—"The fine red pigment known in commerce as carmine is prepared by treating a solution of cochineal with cream of tartar, alum, or acid oxalate of potassium. The fatty and albuminous matters then coagulate and carry down the colouring matter with them." Now in preparing most carmine solutions this precipitation takes place, and the carmine, having greater cohesive (not chemical) affinity for impurities of animal origin than for alcohol, its solution is not readily accomplished by that medium, nor indeed by water. In preparing carmine solution for histological purposes by some of the published recipes, more than one-half of the colouring matter of the carmine is lost in the refuse left upon the filter paper.

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[*] Zeitschr. f. Wiss. Mikroskopie, i. (1884) pp. 101-2.

[†] Amer. Natural., xviii. (1884) pp. 324-7.

There are two ways commonly in use for preparing carminic acid. The first mode is that of De la Rue, which Watts (Dict. Chem., i. 1863, p. 804) gives as follows:—"To separate carminic acid, cochineal is exhausted with boiling water; the extract is precipitated by subacetate of lead slightly acidulated, care being taken not to add the lead-solution in excess; the precipitate is washed with distilled water till the wash-water no longer gives a precipitate with a solution of mercuric chloride, then decomposed by sulphuretted hydrogen; the filtrate is evaporated to a syrupy consistence and dried over the water-bath; and the dark purple product thus obtained is treated with alcohol, which extracts the carminic acid." The second mode is that of C. Schaller and is given by Watts (Dict. Chem., 1st suppl., 1872, p. 413) as follows:—"Schaller prepares this acid by precipitating the aqueous extract of cochineal with neutral lead acetate slightly acidulated with acetic acid; decomposing the washed precipitate with sulphuric acid; again precipitating the filtrate with lead acetate, and decomposing the precipitate with hydrogen sulphide. The filtered solution is evaporated to dryness; the residue dissolved in absolute alcohol; the crystalline nodules of carminic acid obtained on leaving this solution to evaporate are freed from a yellow substance by washing with cold water, which dissolves only the carminic acid; and the residue left on evaporating the aqueous solution is recrystallized from absolute alcohol or from ether."

Schaller's mode of preparation gives purer carminic acid than De la Rue's, but either kind is sufficiently pure for histological purposes. The precipitation by lead acetate and the dissolving in alcohol free the carminic acid from animal impurities, and the consequence is a purer form of pigment than can be extracted by any process hitherto employed for the preparation of carmine for histological purposes.

It is unnecessary to explain to naturalists the advantages of alcoholic solutions of carmine over aqueous ones. The alcoholic solution colours preparations much quicker than the aqueous solution does; for colouring sections, the author employs a solution of 0·25 gr. carminic acid to 100 gr. of 80 per cent. alcohol, and leaves sections in the solution from two to five minutes. A solution of equal carmine strength but in absolute alcohol can be employed; it has, however, no special advantages, since with the 80 per cent. alcoholic solution the sections can be washed directly in absolute alcohol, and then put into oil of cloves or turpentine. Colouring in the piece before sectioning never takes as long with alcoholic carminic acid as it does with ordinary carmine solutions, and if it did take long the strong alcohol would preserve the tissue from maceration. In colouring pieces of mollusca, or of other equally slimy animals, the slime should be removed beforehand, or the staining will be unsatisfactory, because the slime congealing in the alcohol takes up the colouring matter, forming an almost impervious coloured layer on the outside and leaving the inside of the piece nearly uncoloured.

Some preparations coloured in alcoholic carminic acid and then put up in glycerine lost their colour in a few months, the colour seeming to be entirely diffused in the glycerine, while similar preparations mounted in Canada balsam retained their colour perfectly. The author does not know if this fading would occur with preparations coloured with alcoholic ammonic carminate, or even if this diffusion was not due to some impurity of the glycerine (of the purity of which he was doubtful); time to test this matter further failed.

An alcoholic ammonic carminate, or ammonia carmine, can be prepared, at a moment's notice, from alcoholic carminic acid, by adding ammonia drop by drop, and stirring until the entire solution changes from its bright red to purple red. By this mode pure alcoholic ammonic carminate can be produced with no excess of ammonia, and at any time. As the carminic acid can be preserved dry without decomposition, and dissolves quickly in alcohol, one can carry the ingredients of a carmine solution in the vest pocket without inconvenience.

In making and using alcoholic carminic acid pure alcohol and distilled water give the best results, because a portion of the carminic acid is converted to carminates by the salts of impure water. In making alcoholic ammonic carminate this precaution is not as necessary, because the colour of the carminates produced by the impurities of the water is so nearly like that of ammonic carminate.

Alcoholic carminic acid may be used, as Grenacher's carmine solution is used, to colour sections from which the colour is to be afterwards partly extracted by very dilute hydrochloric acid, leaving nuclei red. Another way to use carmine solutions, which is especially applicable to alcoholic carminic acid, is to precipitate the carmine in the tissues by some salt, the carminate of the base of which gives a desired coloration. For example, specimens hardened for a moment under the cover-glass with an alcoholic solution of corrosive sublimate (mercuric chloride) and, after washing with alcohol, coloured in alcoholic carminic acid, take a fine colour of mercuric carminate. So, too, specimens coloured in alcoholic carminic acid can be changed by a few moments' treatment with a very dilute alcoholic solution of lead acetate or cobalt nitrate to a beautiful purple. Sometimes salts in the tissues of the animals change portions of the carminic acid to purple carminates, giving a double coloration without further treatment.

Picric acid added to alcoholic carminic acid in extremely small quantities (best in a dilute alcoholic solution, testing the solution on specimens after each addition) makes a double alcoholic colouring fluid (a so-called picro-carmine). The author has been unable thus far to determine the proportion of picric acid required for this solution, having in every case added an excess. All different kinds of carmine solutions can be made from carminic acid with the advantage of having always uniform strength, of being definite mixtures, and of not spoiling as readily as those made directly from cochineal.

Incompatible reagents with carminic acid are, of course, all alkaline solutions and nearly all metallic salts; with ammonic carminate, are naturally all acids; with all carmine solutions, are bromine and chlorine.

**Hoyer's Picro-Carmine, Carmine Solution, and Carmine Powder and Paste.***—Hoyer proposed † an improved picro-carmine made by dissolving his carmine powder in a concentrated solution of neutral picrate of ammonia. P. Francotte points out that picrate of ammonia is a substance which it is not possible to have constantly at hand, and he has therefore modified Hoyer's preparation in the following manner:—Dissolve 1 gr. of carmine in from 5 to 7 c.cm. of concentrated ammonia, diluted with the same amount of water; in 50 c.cm. of distilled water dissolve (warm) 1/2 gr. of picric acid; mix the two solutions and dilute so as to make 100 c.cm. Then add to the liquid thus obtained 1 gr. of chloral hydrate. If any free ammonia remains, gently warm in a water-bath to drive away the excess, or allow the alkali to volatilize by exposing the liquid to the open air. This solution lasts a long time without changing.

M. Francotte also supplements Prof. Hoyer's description of his process for obtaining carmine solution. ‡ The latter directs chloral hydrate to be added to the neutral liquid to keep it, but does not state the quantity to be used. M. Francotte forms a carmine solution of 10 c.cm. by the addition of distilled water, to which is added 1 gr. of chloral hydrate.

If a paste is required instead of a powder, Prof. Hoyer directs it to be made with alcohol, glycerine, and chloral, but does not give the quantities. M. Francotte uses to 1 gr. of carmine, 2 c.cm. of alcohol, 2 c.cm. of glycerine, and 1 gr. of chloral.

**Dry Injection-masses.**—Prof. H. Fol writes that the red gelatine vermicelli mentioned at p. 312 (carmine emulsions) should be pressed out into slightly acidulated water (1 part acetic acid to 1000 parts water). The carmine will otherwise be washed out.

**Imbedding Diatoms.**§—R. Hitchcock suggests a plan for imbedding diatoms from fresh gatherings. It is to prepare an artificial calcareous rock from a mixture of finely-ground lime and clay, making a kind of hydraulic cement, with which the diatoms may be mingled. When this hardens, the sections may be cut, and isolated by treatment with diluted hydrochloric acid. The large *Pinnularia* is a good species to begin with.

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* Bull. Soc. Belg. Micr., x. (1884) pp. 75–7.

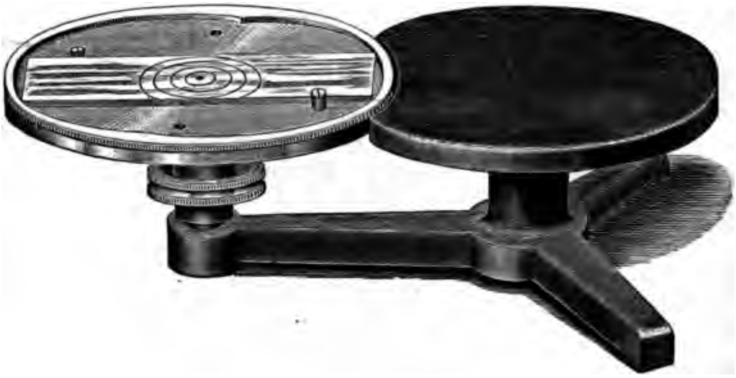
† See this Journal, iii. (1883) p. 142.

‡ Ibid., p. 141.

§ Amer. Mon. Micr. Journ., v. (1884) pp. 54–5.

**Zentmayer's New Centering Turn-table.**[*]—The turn-table represented in fig. 75 is the invention of Mr. J. Zentmayer. The plan of centering the slide is, it is claimed, quite original and perfect in its results. The slide is placed so that its edges are in contact with the two pins projecting from the face of the plate. A ring with an oval inner edge is fitted to the periphery of the disk, in such a way that by turning it the slide is grasped at the diagonally opposite corners by the inner edge of the ring, and is thus centered longitudinally. The two pins centre it the other way. The ring may be easily removed, and spring clips substituted when desirable.

FIG. 75.



**Phosphorus Mounts.**—It was recently stated[†] that diatoms mounted in phosphorus solution cannot be kept for any time. This is not so. Mr. J. W. Stephenson has slides mounted several years ago (one in 1873), which are as good now as at first. All that is necessary is to avoid long exposure to daylight which turns the diatoms an opaque red.

**Styrax.**—On testing this medium (as supplied by Allen and Hanbury) with the refractometer, its refractive index is found to be 1·585 very nearly. It has so much colour that it is difficult to determine the third decimal with accuracy.

If we take the index of diatomaceous silex to be 1·43, and of Canada balsam 1·52, it is seen that styrax gives a marked increase of visibility over balsam, for while balsam is only 9, styrax is more than 15.

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[*] Amer. Mon. Micr. Journ., v. (1884) p. 23 (1 fig.).

[†] Engl. Mech., xxxix. (1884) p. 149.

A. C. Cole* considers gum-styrax to be a "*perfect* substitute for balsam," that it "yields the best possible results," and that it "may be considered absolutely permanent and unalterable." The styrax solution is "even easier to work with than balsam, and air-bubbles are not produced in it by the application of heat."

**Smith's New Mounting Media.**†—Prof. H. L. Smith has been experimenting with various substances to find satisfactory media of high refractive index for the mounting of diatoms, &c. The desiderata at which he has aimed are: 1st, high refractive index; 2nd, a substance to be used in a fluid or semi-fluid state in the process of mounting; 3rd, the property of hardening on the slide, so as to make a permanent mount; and, 4th, a proper cement, to protect it from decomposition if the material is in danger from that cause by reason of exposure to the air or to immersion fluids.

Professor Smith is now assured that he has succeeded in his efforts, and has produced two media, both of combinations entirely new and heretofore unnoticed in chemistry. He has also devised a cement for rings upon the slides to protect the media, which is also new, and makes attractive mounts.

His first medium is a transparent, colourless substance, in the form of a thick fluid, which hardens by heat applied in the same way as in mounting in balsam. The heat expels the fluid part of the mixture, and leaves a solid which is a permanent mount, and requiring no more care in subsequent handling or packing of slides than balsam. The index of refraction of this medium when solidified is 2·00.

The second medium is a yellow-tinted, thick fluid, similar in handling to the last, and to be used and treated in the same manner, but having an index of 2·25 ± when solidified. A perceptible brownish-yellow tint remains in this medium, similar to that of pretty old balsam which has been a little overheated. This medium would naturally be used for special examinations of particularly difficult objects, and the colour is not enough to be objectionable, though the first medium, with its absolute transparency, would be preferred for more common use. Used in a fluid state, the denser medium has scarcely any colour, but its refractive index is of course lowered a little.

In either of them the resolution of *Amphipleura pellucida* is made with surprising ease and strength, and with light of very small obliquity compared with that which has been necessary in dry or balsam mounts. In short, it gives all the results which the high refractive index would lead us to expect, and with none of the objections for cabinet use which belong to the solution of phosphorus and other mixtures.

The cement for ringing is specially devised to avoid any danger of its attacking or decomposing the mounting medium.

The following is a copy ‡ of the report made to the State Microscopical Society of Illinois by a committee to whom were referred some slides of Diatomaceæ mounted in the new media.

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* Methods of Micr. Research, Part x. (1884) p. lvii.

† Amer. Mon. Micr. Journ., v. (1884) p. 71.

‡ 'The Microscope,' iv. (1884) pp. 77–8.

"Your committee carefully examined the slides submitted to them, but gave special attention to the slides of *Amphipleura pellucida* mounted in a nearly white or colourless medium, whose refractive index is stated to be 2 —.

A new Bulloch Professional stand, with a 10-inch tube, was used. It was fitted with a condenser made on the Abbe pattern by Mr. Bulloch, the numerical aperture of which was stated by the maker to be 1·23. The condenser was used with a homogeneous-immersion fluid (cadmium chloride in glycerine). The illumination was furnished by a kerosine lamp with a flat wick turned edgewise toward the mirror, and the light was reflected through the condenser by the concave mirror.

The objectives used were, first, a dry 1/6 of Bausch and Lomb, said to be of 140° air angle, with a Beck No. 3 eye-piece, which gives a supra-amplification of 13·88. The angle of light from the condenser was as high as could be used by the objectives and fully illuminate the object, and with these appliances the lines showed with great distinctness.

We then used a homogeneous-immersion Zeiss 1/18, 1·28 N.A., with the following eye-pieces: Beck No. 1, supra-amplification 5; Beck No. 2, supra-amplification 8·33; Tolles 1 in., supra-amplification 10; Beck No. 3, supra-amplification 13·88; Tolles 1/2 in., supra-amplification 20·83. The illumination was the same, except that the angle of light was as oblique as the condenser could give. With all of these eye-pieces the *beads* showed very strongly.

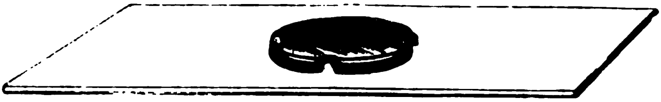
The slide mounted in a yellowish medium with a refractive index said to be 2·3, did not seem to present any marked superiority over the other.

Your committee would expect these media, particularly the colourless one, to be of great value if they keep well. Their advantage in the study of diatoms is obvious. We would also expect them to be even more useful in histology if preparations can be transferred to them without injury. They may also be of great service in the study of bacteria.

By the process of staining, now necessary in the study of these structures, they are shrivelled and perhaps changed in other ways, and we may hope to learn much more about them than is now known if they can be studied in these media in a more natural condition." (Signed by B. W. Thomas, Lester Curtis, H. A. Johnson, H. W. Fuller, and H. J. Detmers.)

**Wilks's Cell.**—Mr. E. Ward supplies cells for mounting without pressure in Canada balsam made on a plan suggested by Mr. Wilks and shown in fig. 76.

FIG. 76.



The cell is made of soft metal and, as will be seen from the figure, has four elevations alternating with depressions, the cover-glass resting on the upper points of the curves. By leaving an excess of balsam round the cell and cover-glass, air-bubbles ultimately escape through the spaces, and loss by evaporation of essential oil in the balsam is provided for. If the cell is too deep for the object it can be pressed between two glass slips until shallow enough.

**Closing Glycerine Cells.**—Mr. W. M. Bale writes: "I see by one or two remarks in the Journal that some manipulators still find a difficulty in securely closing glycerine cells. I have found the following plan obviate all liability to leakage. Use a cell of firm material, such as glass or ebonite, and a cover-glass of larger size, so that when in position it projects outside the cell for 1/12 in. or 1/8 in. all round. Fill the cell and press down the cover-glass, forcing out the superfluous glycerine; then (if on examination under the Microscope the object is found to be properly displayed) put on a spring clip to keep the cover close down, and with a fine syringe wash away the whole of the glycerine which may have exuded from the cell. The space below the projecting margin of the cover-glass will now be filled with water instead of glycerine, and by applying a piece of blotting-paper the water may be absorbed; the slide must then be allowed to stand for a minute or two till the outside of the cell is quite dry, when a little tenacious fluid cement may be applied at the margin of the cover, and allowed to fill the circular space outside the cell. Unless an excess of cement be placed on the slide there will be no tendency whatever to 'run in,' provided that the cell be quite flat, so that the cover can come into close contact with it all round, and that it be deep enough for the object. I formerly recommended this plan for mounting in fluids which would evaporate,* and I since find that it is equally applicable to a dense medium like glycerine, provided that the latter be syringed away from the outside of the cell, as directed. I have young *Hippocampi* preserved in ebonite cells in this manner, but I may add that it is not uncommon to find ebonite cells more or less bent, and such are useless for the purpose, it being essential that the cover should fit closely to the cell, as otherwise the water used in washing would enter it."

**Getschmann's Arranged Diatoms.**—Whether diatoms ought or ought not to be "arranged" is a question which is more often answered in the negative, and in calling attention to the slides prepared by R. Getschmann of Berlin, we have no intention of objecting to the general verdict. We simply record the fact of the existence of the slides, and that they much surpass any of the previous efforts with which we are acquainted. With the diatoms are included Lepidoptera scales, Echinoderm spines, &c.

**Classification of Slides.**†—Dr. C. S. Minot suggests a scheme of arrangement of microscopical (and especially histological) slides based on embryology. The foundation of the system is primarily the germ-layers and then the order of development of the various organs.

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* See this Journal, iii. (1880) p. 864.

† 'Science Record,' ii. (1884) p. 65.

The first division embraces the ectoderm and its derivatives. Here would be placed in order the skin, nerves, glands, teeth, membranes, bones, and organs of sense, and all other organs derived from the outer germ-layer in as nearly as possible the order of their appearance in the embryo.

To the second division belong the endodermal structures, the lining of the alimentary tract, the liver, respiratory organs of vertebrates, endostyle of Tunicates and the thyroid and thymus glands, pancreas, spleen, and stomach.

The mesoblastic tissues may be divided into two great groups: the first, those of the mesenchyma, embraces the spicules of sponges and the skeleton of Echinoderms, smooth muscles, connective tissue, fat-cells, blood, blood-vessels, heart, lymphatics; and, lastly, cartilage and bone. To the other division, to which the term mesothelial tissues may be applied, belong the peritoneum of the vertebrates and its homologues in other groups, striated muscle, and its modification, electric organs, the segmental organs of the lower forms, and the excretory organs of the higher forms, sexual organs, then the stomodeum and its glands, and the proctodeum and its appendages.

The position of the mouth of vertebrates and its accessories is uncertain, as doubts exist whether it is comparable to a portion of the stomodeum of the lower forms or is a superadded feature.

In the case of compound organs the preparations should be placed with their most characteristic elements. Thus the liver should be placed with the hypoblastic tissues, the nerves and skin with the ectodermal, &c. In cases of series of sections of one animal, they of course should be kept together.

Dr. Dimmock adopts a different plan. Each of his slides is numbered in the order of preparation, and then two card catalogues are made, one by organs, the other systematic, each card referring by a number to the corresponding slide. On these cards can be entered full accounts of the specimen, its mode of preparation, the special features presented, &c., and thus with a slight additional amount of labour, the advantages of each system of arrangement may be obtained.

**Blackham's Object-Boxes.**[*]—Dr. G. E. Blackham takes the common rack-boxes for twenty-four slides, and putting on the cover, pastes a piece of stout twilled muslin on the back and lapping over on to the cover. This forms a hinge, and gives the boxes a uniform look. Each box is devoted to a special series or class of objects, and properly labelled, and stands up on end in a revolving book-case. The slides lie flat, and the whole collection is in reach from the working table, without getting out of the chair. For indexing each box Dr. Blackham, with an electric pen, makes a label covering the inner side of the cover, the name of each slide is written on this, on the line opposite the slide itself as it stands in the box. These boxes are cheap, convenient and portable, and are, he considers, preferable to the more elaborate and costly cabinets of drawers.

[*] Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883, pp. 236–7.

**Stillson's Object Cabinet.***—Dr. J. O. Stillson's cabinet consists of a number of trays made of thick pasteboard. They are 9 in. wide and 16 in. long. There are two rows of slides in each tray and 10 or 12 in each row according to the partitions, which can be removed or left in. The depth of the tray is equal to the thickness of the thickest slides, so that when they are in place, each lying flat, they fill the apartment. There is a lid to each tray, also made of pasteboard but stiffened, and made heavier by the addition of a strip of wood, such as is used in making cigar boxes. This strip extends all around the margin of the lid, and there is another across the middle the long way.

Two long openings are cut through the lid, about 2 in. wide, so that when the lid is closed it will press the slides down in their places firmly, but at the same time not touch the cover-glasses. High, dry and opaque mounts can be placed alongside of the thinnest balsam or diatoms, and when it is desired to look for a slide the whole tray can be surveyed with the eye at a glance, and the names of twenty or twenty-four specimens can be read without opening the tray. When the trays are all in the box, the lid holds them firmly in place suitable for shipping. He has borders for the labels printed on fancy coloured paper, and writes in pencil on the wrong side of the label such a history as he desires and pastes it on the slide. Then the name labels are cut with a circular No. 8 punch, and pasted on the border paper. There is plenty of room to write in front the English and Latin names, date and number; by turning the slide round one can read from the back through the glass the history and mode of preparation.

**Pillsbury's (or Bradley's) and Cole's Mailing Cases.**—This "mailing case," the design of J. H. Pillsbury, is intended to supply a demand for some safe and cheap means of packing one or more slides for sending through the post. The entire device comprises three differently shaped pieces of wood (tops, bottoms, and centres) so formed that two, three, or more may be put together as shown in

FIG. 77.

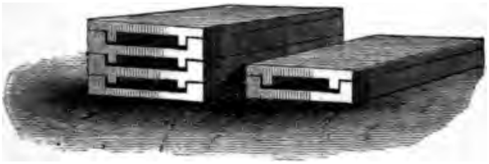

FIG. 78.

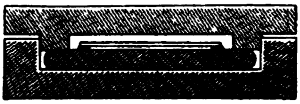

fig. 77. For one slide the top and bottom pieces are used, for two slides the centre pieces also, and so on to any convenient number.

The cross section fig. 78 shows the relation of the parts of the case to the slide. The pinching of the wooden lips on the margin of the glass outside the mounting serves to hold the slide securely in place, and to protect the mounting from possible injury.

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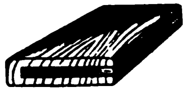
* Proc. Amer. Soc. Micr., 6th Ann. Meeting, 1883.

Every dozen tops and bottoms is accompanied with twenty-four strips of gummed paper which may be used on the edges to secure the pieces before wrapping for mailing. If one slide is to be sent the strips may be gummed lengthwise on the edges. If centres are used for more slides the strips may be used to pass around on to top and bottom. The slight shrinking of the moistened paper in drying pinches the slide sufficiently to hold it securely.

Fig. 79.



A. C. Cole uses the boxes shown in fig. 79. They consist of a piece of wood 3⅛ in. × 1⅝ in. and 1/2 in. thick in which a coarse saw-cut has been made nearly through it as shown in the figure. The slide is placed in the groove thus formed with a little cotton wool and the open side is filled up with a strip of wood about 3/16 in. section.

ADAMS, J. M.—How to keep [send] living Infusoria.
[Dr. A. C. Stokes uses *Lemna* plants which keep the water sweet and supply oxygen while in transit.]
*The Microscope*, IV. (1884) p. 64.

B., W.—Microscopical. [Mounting Cuticle of Leaf.]
*Engl. Mech.*, XXXIX. (1884) p. 132.

BEHRENS, W.—See Boecker, W. E.

BLOCHMANN, F.—Ueber Einbettungsmethoden. (On imbedding methods.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 218–33 (2 figs.).

BOECKER, W. E.—Ueber ein neues Mikrotom mit Gefriereinrichtung, automatischer Messerfuhrung und selbstthätiger Hebung des Objectes. (On a new Microtome with freezing apparatus, automatic knife-guide, and automatic raising of the object). [*Post.*]
*Zeitschr. f. Instrumentenk.*, IV. (1884) pp. 125–7 (2 figs.).
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 244–8 (by W. Behrens).

BOOTH, M. A.—Mailing packages of Diatoms.
[Inquiring how to send small exchanges to foreign countries]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 100.

BORN, G.—Die Plattenmodellirmethode. (The method of modelling by [wax] plates.) [*Post.*]
*Arch. f. Mikr. Anat.*, XXII. (1883) pp. 584–99.
*Amer. Natural.*, XVIII. (1884) pp. 446–8.

BUCHKA, K.—Ueber Hæmatoxylin und Brasilin. (On Hæmatoxylin and Brasilin.)
*Nachr. K. Gesell. Wiss. Göttingen*, 1883, pp. 60–66.

BUCKTON, G. B.—Monograph of the British Aphides. Vol. iv. ix. and 228 pp. (27 pls.). 8vo, London, 1883.
[Contains "The preservation and mounting of Aphides for the Microscope," "The preservation of Aphides for the Museum," and "The dissection of Aphides." *Supra*, p. 466.]

Burrill's (T. J.) Staining fluid, directions for use of.
*Micr. Bulletin*, I. (1884) pp. 21–2.

CATTANEO, G.—Fissazione, Colorazione e Conservazione degli Infusorii. (Fixing, colouring, and preserving Infusoria.) *Concld.*
*Bollett. Scientif.*, V. (1883) pp. 122–8.

Cleaning Slides and Covers—Letter by J. C. Lathrop. [See also *ante*, p. 323.]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 79.

COALE, R. D.—Preparation of the Ethyl Ether of Gallic Acid.
[Cf. III. (1883) p. 931.]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 82.

Cole, A. C.—Studies in Microscopical Science.

Vol. II. No. 15. Sec. I. No. 8. Adipose Tissue, pp. 29–32. Plate 8 × 250.

No. 16. Sec. II. No. 8. pp. 29–34. Epidermal Tissue. Plate 8. T. S. of aërial root of *Dendrobium* × 130.

No. 17. Sec. I. No. 9. Development of Bone, pp. 33–6. Plate 9. Ossification of Cartilage (Quain) × 300.

No. 18. Sec. II. No. 9. pp. 35–8. Vasicular Tissue. Plate 9. Bast, Sieve Tubes and Liber Cells.

„ „ Methods of Microscopical Research.

Part IX. pp. xlix.–lii. Mounting (*continued*). Description of Materials.

Part X. pp. liii.–vii. Mounting (*continued*). The Preparation of Diatomaceæ.

„ „ Popular Microscopical Studies. No. VII. A Grain of Wheat (*concluded*), pp. 25–8.—The Common Bulrush (*Typha*), pp. 29–31. Plate 7. T. S. of Stem, double stained, × 75.

No. VIII. The Intestine, pp. 33–7. Plate 8. T. S. Ileum of Cat injected × 50.

Collins' (C.) Series of 48 Fish Scales. *Micr. News*, IV. (1884) p. 109.

Cornil, —.—Sur le mode de conservation des pièces anatomiques destinées à être examinées au Microscope. (On the mode of preserving anatomical objects required to be examined with the Microscope.

[Brief note only of original paper. The best preserving liquid is 90 per cent. alcohol using a volume at least 20 times as great as that of the piece to be preserved, which should if possible be reduced to 1/2–1 cm. cube.]

*Journ. de Micr.*, VIII. (1884) p. 189, from *Progrès Médical.*

Cox, J. D.—[Prof. H. L. Smith's] New Mounting Media. [*Supra*, p. 476.]

*Amer. Mon. Micr. Journ.*, V. (1884) p. 71.

Coze and Simon, P.—Recherches de pathologie et de thérapeutique expérimentales sur la Tuberculose. (Experimental pathological and therapeutical observations on Tuberculosis.)

[Contains I. Technique.]

*Journ. de Micrógr.*, VIII. (1884) pp. 235–9, from *Bull. Gén. de Thérapeutique.*

Creese, E. J. E.—An inexpensive Turn-table.

["A home-made turn-table which any one with ordinary knack can make for himself at the cost of a shilling."]

*Journ. of Micr.*, III. (1884) pp. 106–7 (3 figs.).

Deby, J.—Notes diatomiques. (Notes on Diatoms).

[I. On MM. Prinz and Van Ermengem's work on the structure of the valves of diatoms (*post*). II. Discovery of *Terpsinoë musica* in Spain. III. Special slides of diatoms by Möller (*post*).]

*Journ. de Micrógr.*, VIII. (1884) pp. 228–31.

Dippel, L.—Die Anwendung des polarisirten Lichtes in der Pflanzenhistologie. (The use of polarized light in vegetable histology.) [*Post.*]

*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 210–7 (5 figs.).

„ „ Kalium-Quecksilberjodid als Quellungsmittel. (Biniodide of mercury and potassium as a swelling agent.) [*Post.*]

*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 251–3.

Durkee, R. P. H.—Mounting in balsam in cells. [*Post.*]

*Amer. Mon. Micr. Journ.*, V. (1884) pp. 84–85.

Edinger, L.—Notiz, betreffend die Behandlung von Präparaten des Centralnervensystems, welche zur Projection mit dem Scioptikon dienen sollen. (Note on the treatment of preparations of the central nerve-system intended for projection with the Sciopticon.) [*Post.*]

*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 250–1.

Elsner, F.—Mikroskopische Atlas. Ein illustrirtes Sammelwerk zum Gebrauche für Gesundheitsbeamte, Apotheker, Drogisten, Kaufleute und Gebildete Laien. (Microscopical Atlas. An illustrated compendium for the use of officers of health, apothecaries, druggists, merchants, and well-informed laymen.) Part I. 9 pp. and 2 pls. of 27 photomicrographs. 4to, Halle, 1884.

[Contains Coffee and Coffee-surrogate. Tea and Tea-surrogate.]

**Fergus, S. T.**—Double staining sections of Buds. *Micr. Bull.*, I. (1884) p. 18.

**Flesch, M.**—Notiz über die Anwendung des Farbstoffes des Rothkols in der Histologie. (Note on the use of the colouring matter of the red cabbage in Histology.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) p. 253–4.

**Frenzel, J.**—Ueber die Mitteldarmdrüse der Crustaceen.
[Contains "Methods of studying the so-called liver of the Crustacea." *Amer. Natural.*, XVIII. (1884) p. 556–7. *Post.*]
*MT. Zool. Stat. Neapel*, V. (1884) p. 51.

**Gage, S. H.**—Notes on the use of the Freezing Microtome. [*Post.*]
*Science Record*, II. (1884) pp. 134–5.

**Giltay, E.**—L'Hématoxyline comme réactif spécifique des membranes cellulosiques non lignifiées et non subérifiées. (Hæmatoxylin as a reagent for non-lignified and non-suberose cellulose membranes.) [*Post.*]
*Arch. Néerl. Sci. Exact. et Nat.*, XVIII. (1883) pp. 437–52.

**Grant, F.**—Microscopic Mounting. IX. Mounting Media. 1. Phosphorus and monobromide. 2. Advantages as to the absence of contraction and as to visibility. 3. Thin aqueous fluids. 4. Advantages of different media with respect to granulation. 5. Thick aqueous media: advantages as to staining and pressure.
[Sec. II. requires considerable correction. *Inter alia*, the refractive index of diatoms is put at "about 1·5," and balsam at 1·528, or a visibility of ·028! Diatoms are stated to be more visible in air than in phosphorus. The disadvantages of air-mounting are not referred to its inapplicability for fine markings, but to a "dulness or mist which gathers inside," &c.]
*Engl. Mech.*, XXXIX. (1884) pp. 148–50.

**Gravis, A.**—Procédés techniques usités à la Station Zoologique de Naples en 1883. (Technical methods used at the Naples Zoological Station in 1883.)
[Summary of various methods previously published, and *post.*]
*Bull. Soc. Belg. Micr.*, X. (1884) pp. 104–27, 132–3.

**Haacke, W.**—Entwässerungsapparate für Macro- und Microscopische Präparation. (Dehydrating Apparatus for Macroscopic and Microscopic Preparations.) [*Post.*] *Zool. Anzeig.*, VII. (1884) pp. 252–6 (1 fig.).

**Hartzell.**—A method of staining the Bacillus [of tubercle.] [*Post.*]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 76–7, from *Medical Times.*

**Hazlewood, F. T.**—Blue Staining.
[The stain—described III. (1883) p. 733—"gives surprisingly fine results with micrococci, bacteria, bacilli, &c." Method of suspending the slides in the water.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 83–4.

**Heitzmann, C.**—Mikroskopische Morphologie des Thierkörpers im gesunden und kranken Zustande. (Microscopical morphology of the animal body in health and disease.) xvi. and 876 pp. (380 figs.). 8vo, Wien, 1883. Also 8vo, New York, 1884.

**Hitchcock, R.**—Styrax and Liquidambar as substitutes for Canada Balsam.
[Recommendation of Styrax.]
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 69–71.

" " Crystals of Arsenic.
[Select a small tube about 1 in. in length, and fit it in a holder made of a thin strip of copper, brass, or other metal having a hole bored through it to receive the tube. Let the mouth of the tube project slightly above the metal, and support the latter in some convenient way over a spirit lamp. Place a small quantity of white arsenic in the tube, and apply heat slowly until a white powder begins to collect about the mouth. Then warm a glass slip, and hold it over the top of the tube until bright crystalline particles appear on its under surface. Then remove the lamp and let the tube cool.]
*Amer. Mon. Micr. Journ.*, V. (1884) p. 71-2.

" " Cleaning Polycystina. " " " " pp. 72-3.

**Hitchcock, R.**—Microscopical Technic. III, IV. Mounting Objects Dry.
*Amer. Mon. Micr. Journ.*, V. (1884) pp. 73–4, 91–4.
„ „ Spring Collections. „ „ „ „ pp. 77–8.

**Hoehnel, F. v.**—Ueber eine Methode zur raschen Herstellung von brauchbaren Schliffpräparaten von harten organisirten Objecten. (On a method for the rapid preparation of useful sections of hard organized objects.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 234–7.

**Hoffmann, F. W.**—Einfacher Einbettungsapparat. (Simple imbedding apparatus.) [*Post.*] *Zool. Anzeig.*, VII. (1884) pp. 230–2 (1 fig.).

**Holzner, G.**—Zur Geschichte der Tinctionen. (On the history of Staining.) [*Post.*] *Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 254–6.

**Jackson, E. E.**—How to Mount Casts.

[After allowing urine to settle, pour off and wash sediment repeatedly with clean water, the object being to get rid of the albumen. The white sediment consists of casts and epithelia. Have ready a solution of eosin, 5 grs. to 1 oz. (water 3, alcohol 1), pour it on sediment, allow to stand 30 minutes, then wash repeatedly as long as colour comes freely. Allow to settle, place a drop on cover, when dry enough to adhere, rinse off with alcohol to get rid of water; dry. Wet with spirits of turpentine and mount as usual in balsam.]
*The Microscope*, IV. (1884) pp. 78–9.

„ „ Mounting Desmids.

[A dip was put in a cell, the water absorbed by blotting-paper, then a drop of mixture of carbolated mucilage of gum arabic and solution of borax was put on the desmids and they were covered and ringed. It remains to be seen whether the medium has bleaching or shrinking properties.]
*The Microscope*, IV. (1884) p. 117.

**Kingsley, J. S.**—Microscopical Methods. II.
[Elementary instruction.] *Science Record*, II. (1884) pp. 124–7.

**L., V. A.**—To Harden Animal Tissues. *Sci.-Gossip*, 1884, p. 89.

**Lagerheim, G.**—Eine Präparirmethode für trockene mikroskopische Pflanzen. (A method for preparing dried microscopical plants.) [*Post.*]
*Bot. Centralbl.*, XVIII. (1884) pp. 183–4.

**Lathrop, J. C.**—See Cleaning.

**Lindt, O.**—Ueber den mikrochemischen Nachweis von Brucin und Strychnin. (On the microchemical analysis of Brucine and Strychnine.)
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 237–40.

**Meyer, H. V.**—Fernere Mittheilung über die Kleisterinjection. (Further communication on paste injection.)

[Further experience of his modification of Pansch's method has proved its value. Remarks on the use of fuchsin and vermilion.]
*Arch. f. Anat. u. Physiol.—Anat. Abtheil.*, 1883, pp. 277–8.

**Michael, A. D.**—British Oribatidæ. Vol. i. xi. and 336 pp. (31 pls.). 8vo, London, 1884.

[Contains description of cells used for observing the development and immature stages, pp. 68–70 (glass rings made from thinnish 3/4 or 7/8 in. tubing and 3/8 in. deep). Collecting and preservation, pp. 99–109. Drawing, pp. 191–5. *Post.*]

**Moeller, J.**—Das neue Patent-Schlittenmikrotom von C. Reichert. (The new patent sliding Microtome of C. Reichert.) [*Post.*]
*Zeitschr. f. Wiss. Mikr.*, I. (1884) pp. 241–4 (1 fig.).

**Pim, G.**—Cell-sap Crystals.
[*Supra*, p. 470.] *Journ. of Bot.*, XXII. (1884) p. 124.

**Pray, T., junr.**—Cotton-fibre and its structure.

[Refers to the "importance of examining cotton by the Microscope," and the "advantages which manufacturing corporations would gain by selecting their stock in this way."]
*Science*, III. (1884) p. 583 (*Proc. Soc. of Arts. Mass. Inst. of Technol.*, April 10).

**Rataboul, J.**—Les Diatomées. Récolte et préparation. (The Diatomaceæ. Collection and preparation. *Contd.*)
*Journ. de Microgr.*, VIII. (1884) pp. 115, 173–6, 231–4.

**Rindfleisch.**—Bacilli of Tubercle.

[They are best stained by fuchsin, soluble in alcohol but not in water. Two or three drops of a concentrated solution in 2–3 cm. of anilin-oil water are sufficient. The staining is especially good at 40° C. The bacilli are uniformly stained if a few drops of fuchsin are added to a mixture of equal parts of alcohol, water, and nitric acid.]

*The Microscope*, IV. (1884) p. 91.

**Sharp, B.**—On Semper's method of making dried preparations. [*Post.*]

*Proc. Acad. Nat. Sci. Philad.*, 1884, pp. 24–7.

**Sharp, H.**—On the Mounting of Objects in cells with Canada Balsam medium.

*Journ. Roy. Soc. N. S. Wales*, XVI. (1883 for 1882) pp. 286–8.

**Simon, P.**—See Coze.

**Slack, H. J.**—Pleasant Hours with the Microscope.

[Spiral vessels of rhubarb, &c.—Oxalate of Lime in Wood Sorrel] [Fish scales] [Proboscis of Ophideres] [Wings of Insects].

*Knowledge*, V. (1884) pp. 240, 282–3 (3 figs.), 330–1 (2 figs.), 371–2 (1 fig.).

**Smith's (H. L.)** New Mounting Medium. [*Supra*, p. 476.]

[See also Cox, J. D.] *The Microscope*, IV. (1884) pp. 77–8.

*Amer. Mon. Micr. Journ.*, V. (1884) p. 80.

**Stowell, C. H.**—Studies in Histology. Lesson I. Injecting. II. Hardening, Softening, Dissociating and Normal Fluids.

*The Microscope*, IV. (1884) pp. 49–56, 80–6.

" " The Measurement of Blood-corpuscles.

[Discussion of recent articles. He considers the relative size of the red blood-corpuscles as given by Gulliver incorrect.]

*The Microscope*, IV. (1884) pp. 60–1.

" " White Zinc Cement.

[Commendation of it when properly put on, in opposition to R. Hitchcock's view that it will run in and spoil the mounts.]

*The Microscope*, IV. (1884) p. 62.

Walmsley & Co.'s Circular on Bacillus Staining. [Vol. III. (1883) p. 310.]

*The Microscope*, IV. (1884) pp. 79–80.

**West, T.**—Naphthaline.

["It is considered by Prof. Williamson of Manchester, to furnish the very best of all substances for imbedding delicate microscopic subjects in previous to cutting sections."]

*Journ. of Microscopy*, III. (1884) pp. 113–4. See also p. 119.

**Wills, —.**—Mounting Desmidieæ.

[Plain water—gold size.]

*Proc. Manch. Lit. and Phil. Soc.*, XXI. (1882) pp. 38–40.

**Wilson, C. B.**—The mesenterial filaments of the Alcyonaria.

[Contains "Methods of preparing the Alcyonaria." *Amer. Nat.*, XVIII. (1884) p. 558. *Post.*]

*MT. Zool. Stat. Neapel*, V. (1884) p. 3.

# PROCEEDINGS OF THE SOCIETY.

**Meeting of 9th April, 1884, at King's College, Strand, W.C., the President (the Rev. W. H. Dallinger, F.R.S.) in the Chair.**

**The Minutes** of the meeting of 12th March last were read and confirmed, and were signed by the President.

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**The List of Donations** (exclusive of exchanges and reprints) received since the last meeting was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Hinde, G. J.—Catalogue of the Fossil Sponges in the Geological Department of the British Museum (Natural History). 248 pp. and 38 pls. 4to, London, 1883 .. .. .. .. | *The Trustees.* |
| Microscope by Chevalier .. .. .. .. .. .. .. .. .. | *Mr. W. Forgan.* |
| Martin, B.—System of Optics. xxiv. and 295 pp., xxxiv. pls. 8vo, London, 1740 .. .. .. .. .. .. .. .. .. | *Ditto.* |
| Collection of Australian Reptiles and Amphibia .. .. .. | *Mr. W. E. Pickels.* |
| Portrait of H. J. Slack, Esq. .. .. .. .. .. .. .. .. | *Mr. Slack.* |

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**The President** said that since their last meeting they had received an intimation from the R. Accademia dei Lincei of Rome, of the death of Signor Quintino Sella, who as President of the Academy was one of their ex-officio Fellows. He proposed that a vote of condolence should be forwarded to the Academy expressing the sympathy of the Society with the Academy in the loss of their illustrious President.

Dr. Anthony having seconded the proposal, it was carried unanimously.

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**The President** proposed that as they were favoured by the presence of Dr. Carpenter, who intended to deal with the subject of binocular vision in the Microscope, the other business on the agenda should be postponed. This was approved by acclamation.

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**Dr. Carpenter** then addressed the meeting "On the Physiology of Binocular Vision with the Microscope," illustrating the subject by some large photographs, drawings on the black-board, &c. He said:—

The reason of my venturing to offer to the Society the views which I entertain upon the subject specified as the title of this communication, is that in the last number of the 'Journal' of the Royal Microscopical Society, at the end of a paper by Prof. Abbe, a doctrine is put forward on the nature of Stereoscopic vision with the Microscope, which appears to me to be inconsistent with our knowledge of the physiology, and also with our experimental knowledge of the phenomena, of stereoscopic vision. It is not, I think, so much a question of optics, as of the physiology of vision. If it was one of optics, I should certainly not venture to put myself in antagonism with one who is probably the greatest living master of the theory of the Microscope. But I think I shall be able to show that it is essentially a question of physiology, and in part also of psychology. Ever since Wheatstone's invention of the Stereoscope, something like fifty years ago, I have had the subject constantly before me: and from the first introduction of the binocular Microscope, I have used it continually for objects of suitable character. So completely, indeed, am I accustomed to it, that when I look at some of the same objects under the monocular Microscope, I scarcely know them again.

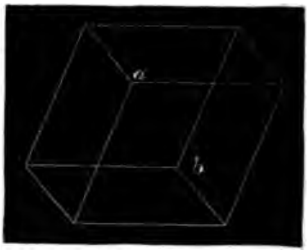
The manner in which we form our visual conceptions from impressions produced upon the retina, is a matter of both physiology and psychology, lying on the border line between the two. Our visual conceptions are formed by the process which is known as "suggestion"; that is, they do not necessarily conform to the visual impressions produced upon the retina, but they are suggested to us by these visual impressions; and it sometimes occurs that our conceptions are erroneous. All who have given attention to the physiology of vision, agree in considering our ordinary interpretations of the solidity of an object placed before us, to be dependent upon a mental co-ordination of our visual and tactile sensations. A child moves its hands towards an object presented to its vision, and educates itself to a conception of its form by the conjoint use of its sight and its touch. It has happened that in some cases persons have obtained sight for the first time, having been born blind, at an age when they have been able to record their impressions of objects presented to their sight, and to manifest their difficulties of interpretation. Many years ago I had the opportunity of observing a child three years old, who had been operated on for congenital cataract. He was too young to describe his impressions to us, but we could observe when he was guided by sight and when by touch, and it was very interesting to watch him under these circumstances. In the lodging where he was staying whilst under treatment, everything about him was strange, and he used his sight and his touch conjointly in familiarizing himself with them until he had learned to correlate the two impressions. But when taken to his own home where the surroundings were perfectly familiar to him, he was for some time entirely guided by touch; he seemed to be quite puzzled by the sight of them, and often shut his eyes in order to understand where he was. Many of you have heard of the case recorded by the celebrated Cheselden, the subject of which, being much older, could describe his own sensations. For a long time after he could see distinctly, he could not distinguish solid objects by vision alone from flat pictures. Not very many years ago, the case was published of a young woman who from birth had possessed enough sight to enable her to distinguish light from darkness, but who could not see the form of any object about her. She had been accustomed to work with her needle; and her thread, needle, scissors, balls of cotton, &c., were all perfectly well known to her by touch. You would suppose that the peculiar form of a pair of scissors, as suggested to the mind through the medium of touch, would be recognized through the sight more readily than anything else; and yet when it was first shown to her, she utterly failed to recognize it as the implement which she had been in the habit of handling. This recognition of a solid form from a visual picture, then, is the result of the experience we gain in very early life, from the association of the mental impressions made by the retinal pictures with those we obtain through the sense of touch,—by which I mean not only the contact with the fingers, but the muscular action which gives movement to them,—so that, in course of time, the visual picture comes to suggest the solid form of the object to the mind. Our best evidence of this is derived from pictures obtained by means of photography; especially those in which the relations of light and shade are strongly brought out; for these pictures suggest the idea of solidity much more perfectly than any others can do. Some of you will probably remember the old Dioramic pictures in the Regent's Park, with their wonderful appearance of solidity, especially in the case of architectural designs; the impression produced being so entirely that of solidity, that it was only by moving the head from side to side that the illusion was detected. These pictures were based on photographs; Daguerre and others having worked out the original "daguerreotype" process for the purpose of producing them most effectively.

In ordinary drawing and painting, an artist is subject to continual changes in the conditions of the light and shade, even in the course of half an hour; and therefore no painting, except one by artificial light, can give a true representation of light and shade at any particular moment. Therefore it is that photographs of many subjects are most wonderfully illusive, and most especially so *when they are looked at with only one eye.* The explanation of this effect is, that when you look at the picture with both eyes, and it is tolerably near to you, you are forced to see it as a flat surface; but when you shut one eye and keep the head still, you lose the power of measuring relative distances; and a visual conception of solid form is suggested by its chiaroscuro and its perspective. If you look, for example, with one eye at the photographs of relievos hanging upon the opposite wall, you will, if you have not tried the experiment before, be astonished at the way in which the figures seem to stand out with all the effect of stereoscopic relief. This is a pure case of mental suggestion; and is due to the perfect similarity of the photograph to the retinal picture produced by natural vision of the object itself upon a single eye. The camera, like the eye, projects a flat picture, which is recorded by photography; and you have then permanently just the picture which one eye would form of the object. You look at this with one eye, and, trained by experience, you interpret what you see according to your preconceived conceptions. A similar effect is obtained when you look at such pictures with both eyes, at a distance great enough for the axes of the eyes to be virtually parallel.

I remember some large imitation relievos on the cornices of some of the apartments in the Louvre at Paris, and some still larger pictures of the same kind in the Bourse, by which the impression of solidity is so well given, that, though the paintings are quite flat, they are generally taken by strangers for real relievos. I have a photograph of a figure in such low relief, that, looking at it with both eyes at a distance of only two feet, you could almost swear to its solidity; the suggestion of solidity given by its lights and shadows being so vivid, as to overcome the corrective effect of the binocular perception of its flatness.

I dwell upon this point, because it underlies the whole inquiry before us. I have here four large photographs of plaques representing the Four Seasons, with the ornamentation and figures in high relief. When you look at three of these with one eye, you will scarcely be able to persuade yourselves that you are not seeing actual relievos, so vividly do the figures stand out. But I have hung one of them upside down; and though you may not all see it as I do, I think the impression upon most persons will be that the figures are hollowed out, instead of raised. In each case the illusion depends mainly upon the light; and it is most complete when there is but one source of light in the room, corresponding with the lights in the photograph. The mental impression is entirely due to suggestion; you know the position of the light, and can tell in which direction the shadows would fall; and when the shadow is made to fall as it would if the object were hollow, then the mind interprets the object as such. Another remarkable instance of suggestion is afforded by this figure of a rhomb (fig. 80), which, as you look at it, may seem to change from one position to another, sometimes appearing to stand upon its narrow side, at other times to be lying on its broad side. Sir D. Brewster says that the perception changes from one to the other, as you feel your mind changing; but I believe that the perceptional and therefore the mental change is the result of the wandering of the eye from the point *a* to the point *b*; for I have never failed to see one or the other aspect, by making my eyes converge upon one or the other of these two points, which then becomes the *salient angle*. This is a case in which two different effects of projection may be produced by the same visual impression; a consideration much dwelt upon by Sir Charles Wheatstone in his original memoir,* as proving that the conception of solid form is *visually suggested* to the mind, not a mere optical effect.

FIG. 80.



I now come to the subject of *Binocular* Stereoscopic vision, which was first elucidated in that memoir. Painters had long been aware of the fact, that if you look at a near object with both eyes, you form different pictures with your two eyes. How is it, then, that we are not puzzled by these different pictures, presented to the mind at the same time? Wheatstone applied himself to the study of this question; and in the course of his investigations it occurred to him that the dissimilarity of the two pictures was really the cause of the sense of projection; and that though we have this sense with a single eye, it is in such case by no means so unmistakable. He therefore reasoned in this way; if you draw two pictures of an object, one as it appears to the right eye, and the other as it appears to the left, and then throw the images of these dissimilar pictures upon the two eyes respectively, you will get a solid effect. The original form of the Stereoscope was a reflecting apparatus, consisting of two mirrors placed together at a right angle, so that each reflected the image of its own picture direct to its own eye; and with this instrument Wheatstone found that two mere outlines of a solid, drawn as already described, and reflected so that each was seen only by the eye for which it was drawn, resulted in the production of a perfect perception of the solid form. No one welcomed this discovery more than Sir David Brewster; who said that it was the greatest that had been made in vision since the time of Newton. This combination of two dissimilar pictures is the fundamental principle of the Stereoscope. In the form of that instrument now familiar to you all, a pair of small photographic pictures, taken in different perspectives, are brought one before the right eye, the other before the left, by two halves of a double-convex lens placed back to back, so as to act both as prisms and as magnifiers. The points of view from which the two pictures are taken, are generally, I believe, about 15° apart; that being the usual angle of convergence of the axes of the eyes at the ordinary reading distance. The late Mr. Claudet, who paid a great deal of attention to this subject in relation to portraiture, tried various angles; and having taken pictures at 5°, at 10°, at 12°, at 15°, and at 20°, he found that 5° gave very little projection, 10° was more satisfactory, but 12° was much better; and for people with nearly approximated eyes it was found to be sufficient; but for most people, 15° was required to bring out the full stereoscopic effect, whilst if he widened the angle to 20° all the projecting parts came out with ludicrous exaggeration. (I have an early stereoscopic photograph of an equestrian statue of Napoleon, showing this exaggeration in a very marked degree, the two pictures having been taken at too wide an angle.)

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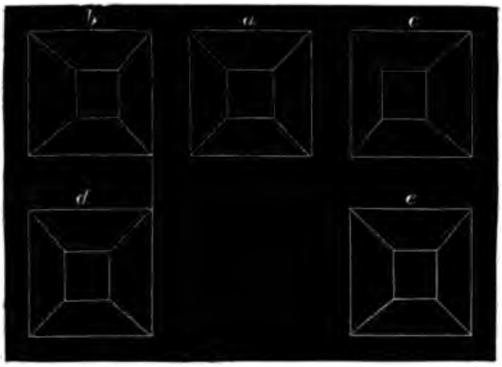
* "On some remarkable and hitherto unobserved phenomena of Binocular Vision." Phil. Trans., 1838, pp. 371-94.

As an illustration, take a truncated pyramid which is placed end-on before one eye, as is shown in fig. 81 *a*; with that eye alone you would be unable to measure the relative distances of its parts, and the borders of its base and truncated top would appear like two squares symmetrically placed one within the other. But if placed in front of the nose, the right eye would see more of the right side of the pyramid (as in the fig. 81 *c*), whilst the left eye will at the same time see more of the left side of it (as in fig. 81 *b*); and if these two pictures are put into the Stereoscope, and each is seen at the same time —the one by the right eye, and the other by the left—the apparent solidity of the figure is brought out perfectly; that is, these two dissimilar pictures, viewed simultaneously, suggest to the mind a conception of the projection of the solid from which they are taken. But if the figure, instead of being solid, was hollow, and was placed before the eyes so as to show its interior, then the right eye would see more of the left side, and the left eye would see more of the right side (as in figs. 81 *e* and 81 *d*); and when these two pictures are put into the Stereoscope, the centre appears to recede in an unmistakable manner. I have here a stereoscopic slide showing these two pairs of pictures at the same time; and if you look at it in the Stereoscope, the "conversion of relief" produced by the "crossing" of the right and the left hand pictures of the pyramid, will be at once apparent.

But in addition to these impressions of solid form, another very curious fact now comes out. The four small squares are of exactly the same size in the pictures; and yet as you look at them in the Stereoscope, you will all say that the square at the end of the hollow pyramid seems larger than the other. The apparent excess differs in different persons; for some see the receding pyramid as if much deeper than others, and describe it as like a tunnel; and to them the small square looks very much larger. This is another case of mental suggestion, and one which no optical diagrams can explain, because it is clear that the retinal pictures must be of exactly the same size, however different they may seem *visually*. Sir Charles Wheatstone in his second Memoir (Phil. Trans., 1852) clearly proved, by experiments made with his improved reflecting Stereoscope, that our conception of the size of an object pictured on the retina ordinarily depends on our appreciation of its distance; and that this again (in the case of a near object), depends upon the convergence of our optic axes. If we have an object of known size, and we bring it nearer to the eye, it does not seem to be a larger object: because we know that though it subtends a wider visual angle, making the retinal picture larger, its distance from us has diminished. And he showed that by making the optic axes converge, and so suggesting to the mind that the object was approaching, though it was not brought

FIG. 81.



nearer (its retinal picture remaining of the same size)—it seemed to become smaller; while, by opening out the angle of convergence, the pictures seemed to grow larger. Here, then, we have a most perfect example of an automatic mental interpretation, in which the apparent size is determined by the conjoint impressions we are receiving from the convergence of the optic axes and the actual size of the retinal pictures. And so when the mental interpretation of the stereoscopic form throws the small square back, and the visual picture remains of the same size, the fact of its receding without diminishing suggests the mental impression that it is of a really larger size. There is no gainsaying these things; they are simply facts in Mental Physiology; and, as I have already said, they are not a matter of Optics, but the results of a *mental* process of *interpretation* of the visual impressions received.

I might go on to demonstrate this still further by means of the Pseudoscope, if time permitted. This is an arrangement of prisms for bringing the right-hand picture of an actual object to the left eye, and the left-hand picture to the right eye; and just as the "crossing" of two stereoscopic pictures produces a conversion of relief in the composite image, so does this reversal of the combination suggest to the mind a reversal of the relief of the image of the actual object. The effect of "suggestion" is well shown by a simple experiment. Here is an ordinary tin cake-mould; now if you place this before one eye so that the light falls directly into it, and you look at it with that eye alone, inasmuch as you are more accustomed to see the solid form than the hollow, you will probably see it projecting towards you. (To see it in this way, there must be no shadow, for this will oblige you to recognize its concavity.) The experiment is best made by daylight, the mould being held up so as to face the person looking into it with his back to a window. The picture that falls on his retina is virtually that of a flat surface; seeing it as such, he has to interpret the meaning of that picture; and as he is more accustomed to see the solid form than the hollow mould, the latter is preferentially suggested to his mind. As another very curious instance of this kind of suggestion, I have here a mask, which I long ago got one of my sons to paint inside, just in the same way that the outside is usually painted. If this is held up so that there is no shadow, and a person looks into it steadily with one eye, the mental impression is that of projection. I was about to write a paper on Binocular Vision and the Stereoscope for the 'Edinburgh Review,' and I asked the editor to come to my residence and see a few experiments. I placed him with his back to the window, and then, holding up this mask with the inside towards him, so that the light fell into it without causing shadow, I asked him to look at it with one eye, and to say what he saw. He said at once that he saw the face of an ordinary mask. I then told him to open the other eye, and he was utterly astonished to find that he had been looking at the inside. Sir Charles Wheatstone told me that by long looking at a bust with his Pseudoscope, he had been able to reverse its relief; but that he could never do so with a living human face. And I have found that although, by crossing the pictures in the

Stereoscope, any conceivable reversion can be made, no such conversion of relief will take place when two portraits taken stereoscopically are thus crossed—the mind refusing to accept the suggestion.

Having thus fully prepared my ground, I shall briefly deal with my proper subject. Prof. Abbe, as I understand him, says that the perception of relief in the case of the Binocular Microscope is something different from that of ordinary stereoscopic vision; and that it depends more upon the relative planes of portions of the object. I maintain, however, that it depends upon the combination (as in the Stereoscope) of two dissimilar perspective projections. We all know that the conception of solid form or projection which we get with the *stereoscopic* Binocular (in which the prism divides the cone of rays into its right-hand and left-hand halves), is very different from that which we get with the *non-stereoscopic* Binocular, in which half the rays of the entire cone are sent into each of the two bodies respectively. Every one also knows that in viewing a solid object he cannot get adequate focal depth with a very wide-angled objective. When our makers were bringing out 1/2 in. objectives of very wide angles, up to 90°, I tried one of them on a slide of *Polycystina*, but could make nothing of it; for a portion of a spherical form (which was all that could be brought into focus) looked very much like the small end of an egg. When I reduced the angle to 60°, the same portion of a sphere looked like the large end of an egg; but when I further reduced the angle to 40°, I saw every form in its true projection. I got Mr. Powell to construct for me a 1/2 inch objective of 40°; and this has been the progenitor of a goodly offspring of low-angled objectives, which give, in the Binocular, the real solid forms of opaque objects. I maintain that the pictures which we receive from the two lateral halves of such an objective, are as dissimilar as two portraits taken at an angle of 15°; and that it is by the stereoscopic combination of these, that the impression of solidity is suggested.

It is interesting to go back to Mr. Wenham's first paper on this subject,* written just thirty years ago. He was then working out the problem of the Binocular Microscope: rightly apprehending the principle of the Stereoscope, he attempted to reproduce its effects in the Microscope; and you know how he ultimately succeeded, although his first results were unsatisfactory. Prof. Riddell also at first failed, and for the same reason,—that they both lost sight of the fact that as the Microscope itself reverses the pictures, it is necessary that they should be made to cross before reaching the eyes of the observer. Some among you will no doubt remember, that the first binocular Microscopes which were made, gave such a view of the objects, that though you sometimes saw them stereoscopically, the general effect was pseudoscopic. Now, Mr. Wenham in the course of his investigations did this;—he took a very suitable object for the purpose, the egg of a bug, and having put it under a 2/3 in. objective, he covered up half the lens and made a drawing of the object as it then appeared; he then covered up the other half, and made another drawing. You can see for yourselves that these two figures are two dissimilar pictures; and I have found that they pair perfectly well in the Stereoscope, bringing out the object in relief. I have at home two photographs taken in the same way, showing by their combination precisely the same result.

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* Trans. Micr. Soc., ii. (1854) p. 4.

Another very curious piece of evidence, furnished by the dissimilarity of the pictures given by the two lateral halves of a portrait-lens, will strengthen my case. In 1857 Mr. Claudet brought before the Royal Society this very interesting fact:—"I have noticed that when I hold my head in a certain position behind the focusing ground glass, I see the sitter, not as a flat picture, but as an image in relief. But this image is only to be seen when my head is in a certain place; if I move it to either side, or either forwards or backwards, I lose the effect." He found the explanation of it to be, that in that particular position the picture taken by the left half of the lens came to his right eye, while the picture formed by the right half came to his left eye; whilst, if he moved so that he broke the lines of these two images, he lost the effect; he further found that if he covered up either half of his lens, the solid image gave place to a flat picture, proving the combination of the two to be required to give the impression of solidity. He found that the effect of relief was most decided, when rays forming the picture were only allowed to pass through an aperture at each end of the horizontal diameter of the lens, all the rest being stopped out; while the appearance of solidity was lost when only the central portion of the lens was employed. Further, he found that the illusion of relief is not produced when the image was received on translucent paper instead of on ground glass; the reason of this difference being that, as all the molecules of the ground glass are in themselves transparent, though their surfaces are turned into lenses or prisms by grinding, some of the rays *pass through it* to the eyes; whilst, when the image is thrown upon paper, the rays are stopped by the opacity of its fibres, each molecule of which, becoming self-luminous, sends out its rays in all directions, so that one and the same picture of the object is seen by both eyes. Mr. Claudet obtained further proof of the correctness of his interpretation by placing a blue glass before one of the marginal openings of his portrait lens and a yellow glass before the other. The image seen when the eyes were in a position to receive and combine the two pictures was of a grey tint. But if one eye was closed, the image became blue; and if the other was closed, it became yellow,—the same effect being produced by moving the head to one side or the other.* Although Mr. Claudet's view of this matter was denounced by Sir D. Brewster as completely at variance with the laws of optics, yet he subsequently succeeded in establishing it beyond question by the construction of his Stereo-monoscope; † in which the like effect was given by throwing on the same part of a ground glass, by two separate lenses, two distinct pictures of the same object taken stereoscopically. These apparently coalesced into a single flat picture; but when the head was so placed that each eye received the rays issuing from the picture of the opposite side, the same effect of relief or projection was obtained, as if the two pictures had been combined by means of the ordinary Stereoscope.

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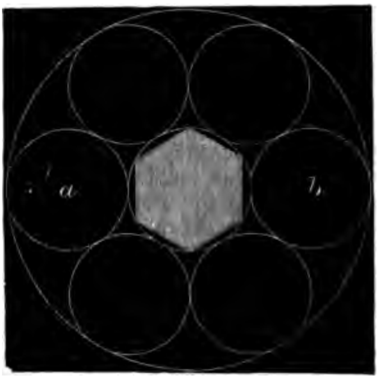
* Proc. Royal Soc., viii. (1856-7) p. 569.

† Ibid., ix. (1857-8) p. 194.

Now I cannot see how these facts are to be accounted for in any other way, than by the admission that the pictures formed of any object in relief, by the different parts of a lens of sufficiently wide angle of aperture, are sensibly different in their perspectives,—as a very simple construction shows that they ought to be. Thus, if we were to place a hexagonal prism under a lens of three times its own diameter (fig. 82), and were to take a picture of it first through the central circlet only, and then through each one of the peripheral circlets in succession—all the rest of the lens being stopped out—we should have seven dissimilar pictures: that given by the central circlet showing only the hexagonal top of the solid, but in its true figure; whilst that formed by each of the peripheral circlets would give a foreshortened view of the hexagonal top, but would also bring in oblique views of three sides of the prism. Now, in the case described by Mr. Claudet, we should only receive the images from the two *lateral* circlets *a b*; and these "pair" so as to bring out the effect of relief, because they correspond with the two dissimilar perspectives which would be formed upon our two retinæ, if we were viewing the solid prism (enlarged to its apparent size) at the ordinary visual distance.

Fig. 82.



But, it may be asked, if this is the real state of the case, how is it that we obtain anything like a distinct image of any solid *projecting* object viewed monocularly—that image being the composite resultant of a number of superposed pictures differing sensibly one from another. When the object is either flat or in low relief, the pictures will not sensibly differ, unless taken with a lens of much wider angle than the 40° which (as I have already stated) I regard as the true limit for an objective to be used with the stereoscopic binocular. Now we have in Mr. Francis Galton's remarkable "composite portraits," a proof that pictures even of different individual men, having the same general facial proportions, but expressions so different that each may be at once distinguished from the other, may be blended photographically into one image which would not be remarked-on as wanting in definition. And so the pictures formed of such an object as a Polycystine, *Eucyrtidium* or *Podocyrtis*, by the several circlets (as in fig. 82) of a lens of 40° aperture, though actually different, will blend into a composite image —a sort of visual average. But when the two lateral halves of such a lens are made, by the stereoscopic binocular, to give to the right and left eyes respectively separate and sensibly dissimilar pictures, corresponding in their perspective projections to what the real object would give to the right and left eyes, if enlarged to the same size, and placed at 10 in. distance from them — then the visual conception of solidity is vividly called up. As I have already shown you, this conception may be excited also by other suggestions—a one-eyed person being able to see objects in relief, as a microscopist sees them in a monocular instrument. But there is nothing which so strongly and uniformly excites this visual conception of solid form, as the combination of the two dissimilar perspectives; and this seems to me to be effected by the instrumentality of the Stereoscopic Binocular, exactly as (by Sir C. Wheatstone's admirable demonstrations) we know it to be effected in ordinary binocular vision.*

**Mr. Crisp** said that at that late hour he would compress into a brief compass his remarks in support of Prof. Abbe's view.

So far as Dr. Carpenter intended only to insist that stereoscopic vision in the Microscope resulted from two dissimilar images, there was no disagreement between himself and Prof. Abbe, and this being so, nearly all of Dr. Carpenter's interesting discussion was not really in controversy so far as Prof. Abbe was concerned.

The difference between Dr. Carpenter's view and that of Prof. Abbe was as to the mode in which the two dissimilar images were formed. Dr. Carpenter suggested that they are formed in the Microscope just in the same way as in the case of the naked eye, i. e. perspectively; whilst Prof. Abbe insisted that oblique vision in the Microscope is entirely different from that in ordinary vision, inasmuch as there is no perspective; so that we have no longer the dissimilarity which is the basis of the ordinary stereoscopic effect, but an essentially different mode of dissimilarity between the two pictures.

If we look at a small cube with the naked eye from an oblique direction it will be agreed that we shall see it as a perspective projection upon a plane at right angles to the direction in which we are looking, with the well-known perspective shortening of all lines which are not parallel to that plane. In the Microscope, however, according to Prof. Abbe's view, there is no such perspective shortening, but the cube is imaged in the manner described in his paper. †

That the latter is the correct view is proved by the fact that there is no difference in the outline of an object viewed under the Microscope by an axial or by an oblique pencil; there is simply a lateral displacement of the image—an entirely different phenomenon to that which occurs in non-microscopic vision. Again, in ordinary vision, a lined object will appear to have its lines closer and closer together according as it is seen more and more obliquely. In the Microscope, however, we have the same number of lines to the inch whether the object is seen by an axial or an oblique pencil.

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* [*Addendum.*—I wish it to be distinctly understood, that in this discussion I refer exclusively to microscopic images formed *dioptrically* by objectives of low power and small angular aperture, and not to those formed (as Prof. Abbe has shown) by the combination of *diffraction-spectra.*—W. B. C.]

† *Ante*, p. 20. See also i. (1881) pp. 422-3.

This essential difference between naked-eye and microscopic vision by oblique pencils (which Prof. Abbe had been the first to point out) was most important to be kept in mind, as the opposite assumption had led to some of the greatest of the mare's-nests of microscopy ("All-round Vision," &c.).

The admission of this difference, however, did not invalidate any of the practical illustrations which Dr. Carpenter had given. The experiments of Mr. Claudet and Mr. Wenham, for instance, were performed with objectives of low aperture. Now the difference between the two modes of oblique vision varies as the cosine of the angle of obliquity, so that up to the limit of angle for objectives suitable for binocular work, say 40°, the difference does not exceed 1 per cent.—an amount quite inappreciable by the eye.

**Dr. Carpenter** said he was not sorry to find that Prof. Abbe and himself were not so much in difference as he had thought to be the case. With large apertures, however, the whole conditions of vision were so entirely different that they could scarcely be compared; while, as regarded images of lines, they were so mixed up with diffraction effects that the question was necessarily in a very unsettled condition. If, however, Prof. Abbe was in agreement with him as to apertures under 40°, then clearly there was no question between them.

**The President**, in proposing a vote of thanks to Dr. Carpenter, said that he was sure he was in accord with the unanimous feeling of all present, in expressing the gratification which Dr. Carpenter's presence that evening had afforded them.

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**Mr. E. M. Nelson's** observations on the *Bacilli* of tubercle were referred to by Mr. Michael, who said that Mr. Nelson had found that when examined with dark-ground illumination they take the light in an unexpected and peculiar manner, appearing like grains of gold-dust on black velvet. The best effect was obtained by Swift's 140° condenser, with stop, illuminated by a lamp having a large-angled bull's-eye accurately centered and focused, and the plane mirror. Excellent images are obtained by this method with a 2/3 in. and 1/2 in. eye-piece or a 4/10 and a 1 in. eye-piece. Mr. Nelson thinks three advantages accrue from this kind of illumination:—1st. The low power by which the organisms may be studied. 2nd. The great ease with which they may be detected in tissue; and 3rd. Saving to the eyes.

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**Mr. Badcock** described some observations he had recently made on some specimens of *Surirella bifrons*, which showed small processes similar to those found in the Arcellinæ, and by means of which the diatoms seemed to be moved to and fro (see p. 352).

**Mr. Guimaraens** described a slide showing a true *Xanthidium* in Halifax coal strata, discovered by Mr. James Spencer, of Halifax, who also prepared the slide.

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**Mr. Bolton's** note was read on the finding in Epping Forest of the Rhizopod *Clathrulina elegans*, which forms a transition from the fresh-water Heliozoa to the marine Polycystina. This was, Mr. Bolton believed, the first discovery of it in England.

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**Mr. Crisp** asked that any Fellows finding *Megalotrocha alboflavicans*, or *Lacinularia socialis*, would send living specimens to Dr. C. T. Hudson, who was much in want of them for his forthcoming work on the Rotatoria.

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**The President** announced that the following resolution had that evening been passed by the Council, and gave notice that a special meeting of the Society would be held on the 14th May next, for the purpose of taking it into consideration, and passing such resolutions as might be considered desirable, whether by alteration of the by-laws or otherwise:—

"That it is expedient that ladies should be admitted as members of the Society, either as Fellows or Associates, or under such other title as the Society shall determine, provided that they shall not attend the ordinary meetings."

The President also announced that in consequence of the change of librarian, the second Conversazione would be omitted for this session.

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**The following Instruments, Objects, &c., were exhibited:—**

Mr. Badcock:—Slide in illustration of his paper.
Mr. Bolton:—*Clathrulina elegans.*
Dr. Carpenter:—Photographs in illustration of his paper.
Mr. Crisp:—Paraboloid for rotating illumination in azimuth.
Mr. Guimaraens:—*Xanthidium* in Halifax coal strata.

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**New Fellows.**—The following were elected *Ordinary* Fellows:—Messrs. Charles Botterill, Aristides Fournet, Rev. T. M. Gorman, Henry Gradbe, M.D., G. Massee, Benjamin Owen Meek, Gerald Sturt, and John Michael Williams.

## SPECIAL AND ORDINARY MEETINGS OF 14th MAY, 1884, AT KING'S COLLEGE, STRAND, W.C., THE PRESIDENT (REV. W. H. DALLINGER, F.R.S.) IN THE CHAIR.

**The President**, in opening the special meeting (called for the purpose of considering the proposed admission of ladies as Fellows of the Society), requested Mr. A. D. Michael to move a resolution.

Mr. Michael said he found himself unexpectedly charged with the resolution under circumstances which he would explain. He thought he should not be making any unnecessary disclosure by saying that the Council were led to the consideration of the matter by an application which was received from a Fellow of the Society (Sir Henry W. Peek, Bart., M.P.), inquiring if it was in order for him to nominate a lady as a Fellow of the Society. Being thus appealed to, the Council considered the matter, and on its being found that under their present by-laws it was not possible to do what was asked, some of the Council were of opinion that it would be desirable to admit ladies, pure and simple. He, for one, however, was not able to see his way clear to agree with so large a proposition, and his share in the matter was connected with the proviso at the end of the resolution which was approved by the majority of the Council. As it thus originated with him, he became charged with the duty of submitting it to the meeting. The feeling of the Council, as expressed by the resolution, was that there could be no objection to ladies being admitted as Fellows, provided that they did not attend the ordinary meetings. For his own part, he could not but see grave objections to the admission of ladies at the ordinary meetings, because in the course of their proceedings subjects were often introduced which English gentlemen could not freely discuss in the presence of ladies. At least, this had been found to be the effect at other societies where ladies had been admitted without limitation. For this reason he was opposed to the proposal as originally made; but if there was a feeling that ladies should be admitted to the other privileges of the Society—the library, the instruments, Journal, &c., he did not see any objection to it. He thought that probably the majority of the very few ladies who might be called practical workers with the Microscope would desire to share in those privileges only, and that those who could give the Society the most assistance would not, under any circumstances, attend the meetings. He also wished it to be understood that in moving the resolution there was no desire on the part of the Council to force the matter upon the Fellows. All that was intended was to submit the question to them for their consideration and to invite discussion upon it. With this view he moved —" That ladies shall be eligible as Fellows of the Society, and shall be subject to all the obligations and entitled to all the privileges of Fellows, except that they shall not be entitled to attend the ordinary meetings of the Society."

Dr. Anthony seconded the motion.

Mr. Crisp called attention to the fact that a special notice of this meeting had been posted to all Fellows in the United Kingdom.

Dr. Coffin moved as an amendment that the last fifteen words of the resolution (from and including the word "except") be omitted, so that ladies should be admitted to all the privileges of Fellows, including attendance at the ordinary meetings.

No one rising to second the amendment, the President put the original resolution to the meeting, and declared it to be carried.

The special meeting then terminated.

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**The List of Donations** (exclusive of exchanges and reprints) received since the last meeting, was submitted, and the thanks of the Society given to the donors.

| | From |
|---|---|
| Catalogue des Collections du Musée de l'Industrie. 241 pp. 8vo, Bruxelles, 1846 | *Le Bibliothécaire.* |
| Musée R. de l'Industrie—Bibliothèque Technologique—Catalogue. 275 pp. 8vo, Bruxelles, 1878 | *Ditto.* |
| 45 Slides illustrating vol. i. of the 'Monograph of British Oribatidæ | *Mr. A. D. Michael.* |
| Slide of *Halecium halecinum* | *Mr. H. C. Chadwick.* |
| Slide of Objects found in Flue-dust and Coal-ash | *Miss Dancer.* |
| Slides of Sand obtained by washing clay from the boulder drift of Minnesota | *Mr. B. W. Thomas.* |
| Fish-trough | *Mr. A. W. Stokes.* |

The following letter from Mr. Michael referring to his donation was read:—

"I send the type series of British Oribatidæ which I proposed giving to the Society. It corresponds exactly with vol. i. of my work on the British Oribatidæ, just published by the Ray Society.

The series includes all the species mentioned in the book, except two, of which I have not any duplicates. It also includes many of the immature stages.

I have marked the slides with a running number so that if they get out of order they can at once be restored to the arrangement of the book. I have also put a separate list of the slides with them.

Blanks are left for the two species of which I do not possess duplicates. Should I obtain any at any time I will fill up these blanks; I shall also hope to deposit a similar series illustrating the second volume, whenever that shall be published.

I have announced in the preface of the book that the types have been deposited with the Royal Microscopical Society.

Finally, I venture to hope that others may follow my example, and that it may assist in ultimately placing the Society in possession of such a collection of typical and interesting slides as it ought to have."

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Dr. C. H. Golding-Bird exhibited and described his new freezing microtome, which was intended to be put into the hands of students and intermittent workers. It was graduated to cut sections of less than the 1/1000 in. in thickness, whilst in one form it was adapted for the use of ice and salt, and in another for use with ether spray.

Mr. Groves, in reply to the President, said that he had had the pleasure of seeing and examining the microtome, and it seemed to him to be a most perfect and useful little instrument.

The President considered one of its advantages to be that it maintained the temperature at the same point for a much longer period than most others.

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**Dr. P. Herbert Carpenter** gave an account of his views respecting the nervous system of the Crinoidea, which he illustrated by diagrams drawn upon the board, and by numerous preparations exhibited under Microscopes. He directed attention more particularly to the branches from the axial cords of the skeleton, which extended upwards into the ventral perisome at the sides of the ambulacra both of the arms and of the disk. The material was chiefly derived from the collection of the 'Challenger' expedition, and the results when complete will be embodied in the volume in course of preparation.

Dr. Carpenter, C.B., said he was very glad that his son had brought this subject forward, because it formed an extremely good illustration of the value of microscopical investigation where important questions had to be determined. In this instance a great deal hung upon the point whether these cords were nerves or not; for if they were, then it was clear that the whole of their present system of classification of Echinodermata must undergo revision, because all morphologists had been trying to show the analogy of this group to the star-fishes, of which they were considered to be only a family. He had, however, always held, from a careful study of them during the last thirty years, that the general structure of the crinoids was formed upon a plan very different from that of the star-fishes. Of the various arguments which his son had brought forward to prove the truth of that idea, the anatomical argument was the most important, as being a confirmation of what he had himself previously advanced; for it must be remembered that at the time to which he had referred, many things could not be demonstrated because they had not then known how to cut thin sections. Very early in his investigations he had found that a cord which had been discovered by Müller, and considered by him to be a nerve, was a genital rachis, which would develope afterwards according to the sex of the specimen. But by the adoption of thin section-cutting a flattened band was discovered beneath the ambulacral groove, which all the German observers, and Professor Huxley also, at once concluded to be the nerve, because a nerve ought to be there. In the star-fishes it certainly was so; but it was certainly not the only nerve in crinoids. He was early led to regard as a nerve a cord running continuously through the calcareous segments of the arm, and originating in a central organ in the base of the calyx. This organ, which is an expansion of the summit of the original crinoid stem, is divided into five chambers, from the outer walls of which proceed five radial branches; and these branches inosculate with each other laterally so as to form a circular commissure from which branches are given off to the arms, thus establishing a nervous connection amongst them all, of which no one could doubt the existence who has ever seen these feather-stars in the act of swimming, or simultaneously coiling up their arms on irritation of the oral pinnules which arch over the mouth. He had experimented upon the matter in various ways. Having turned out the visceral sac, he passed a needle down and irritated this central organ, and immediately all the arms coiled up together. Again, he turned out the visceral mass entirely, thus getting rid of the centre of the *ventral* nerve-system, and put the animal—which then consisted of a mere skeleton—into the water; it swam just as well as before, with the same beautifully co-ordinated movements of its ten arms. He then tried the experiment of dividing this ventral nerve, but found that it did not paralyse any of the parts beyond. But when he removed the centro-dorsal cup containing the central organ of what he regarded as the *dorsal* nervous system, the whole of the arms were tetanized, from the contraction of the ligaments without any muscular antagonism. He then endeavoured to cut through this nerve without separating the arm; but was unable to do this successfully, as the animal threw off the arm at once. He therefore contrived to burn it away with nitric acid, and then found that the arm was paralysed.

These experiments, and the anatomical descriptions which his son had given, so entirely agreed that he thought there was no getting over the proof that the muscular apparatus of the arms of crinoids is put in action, not by a *ventral* nerve-system homologous with that of other Echinoderms, but by a *dorsal* nerve-system peculiar to themselves. He thought they were perfectly conclusive; and referring to the well-known story of George Stephenson and the cow, thought that if the homologists still persisted in going against the facts, so much the worse for the homologists. What, therefore they had to do was to ascertain exactly what was the true morphology of the crinoid; and it seemed to him that its most beautiful skeleton was more like that of the Vertebrata, because it was modelled upon a nervous system. The joints of the crinoidal stem, and all the segments of the rays which issue from its summit are penetrated by a canal for the nerve-cord; but this canal is not found in the dermal or accessory plates which constitute a large part of the skeleton of many fossil crinoids. The existence of this canal became, therefore, of great importance; if it was a canal for the passage of a nerve, then it became a fundamental feature in the organization of a crinoid. The crinoids were exceptional also for the wonderful activity of their movements; no star-fish certainly had anything like the activity or co-ordinated movements of a crinoid. He thought, then, that they ought to say that the skeleton which incloses the nervous system is the fundamental basis of the crinoid; and that there was but a very imperfect analogy between it and that of the star-fishes. The question afforded, to his mind, a very important lesson as to not allowing theory to go against fact; and also that microscopical examination was of the greatest value in the determination of questions of this kind.

Dr. Matthews inquired what reagents were employed by Dr. P. H. Carpenter in the preparation of his specimens.

Dr. P. H. Carpenter said he had used hæmatoxylin sometimes, also osmic acid, or picro-carmine or borax-carmine.

**Herr H. Boecker's** collection of slides of Bacteria, Bacilli, &c., exhibited in the room, were referred to by Mr. Crisp as one of the best yet seen in this country.

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**Mr. Crisp** exhibited a curious Microscope, with a sliding nose-piece for three objectives, marked "Joseph Brum, Opticus in Instituto Bononie, F.A., 1772," but identical (except the nose-piece) with plate II. in the 4th edition of G. Adams, sen.'s treatise on the Microscope (1771). The nose-piece was an anticipation of the plan adopted in more modern times in the Harley Microscope and others. He also exhibited the two Microscopes by Reichert and the apparatus mentioned in the list of exhibits.

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**Mr. Griffith's** multiple eye-piece was exhibited by Mr. Crisp, and discussed by Dr. Matthews, Mr. Powell, and others.

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**Mr. Crisp** mentioned that notice had been received that the American Society of Microscopists would hold their annual meeting at Rochester, N.Y., on the 19th of August next, and as their President, one of the Vice-Presidents (Mr. Glaisher), and a member of the Council (Mr. A. W. Bennett), were going to Canada, the Council had resolved, subject to the confirmation of the Fellows, to ask them to attend the meeting as a deputation from this Society.

The proposal having been put to the meeting, was approved unanimously.

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**The following Letter and Report** were read and ordered to be entered on the minutes:—

"New York, March 31st, 1884.

Dear Sir,—At a regular meeting of the New York Microscopical Society, held on the evening of the 21st instant, at No. 64, Madison-avenue, the report of the Committee appointed to present in a formal manner the sentiments of the Society in view of the death of Mr. Robert B. Tolles was read and accepted. On motion it was ordered that a copy of said report be sent to the 'American Monthly Microscopical Journal' and the 'Royal Microscopical Journal.' I have the honour herewith to enclose a copy as stated.

I am, &c.,
Edward G. Day,
*Cor. Sec.*"

Mr. Frank Crisp, Sec. Royal Microscopical Society.

"Your Committee, appointed at the meeting held December 21st, to present in a formal manner the sentiments of the Society, in view of the death of Mr. Robert B. Tolles, find in the remark made by Mr. William Wales at that meeting a fitting and satisfactory expression of said sentiments. Mr. Wales said in substance:—

'The death of Mr Tollès has been to me a source of deep regret. For modesty, for uprightness, for earnestness of purpose, he was one of the most estimable of men. A larger capacity than his, a firmer and finer skill, a more artistic feeling, a sterner conscientiousness, has seldom, if ever, been devoted to the work of making the Microscope a thoroughly efficient and trustworthy aid in scientific research. The fortunate owner of one of his fine lenses possesses one of the most exquisite pieces of mechanism ever produced by the mind and hand of man. Mr. Tolles loved his beautiful art. He loved it better than riches; for he died a poor man. He loved it better than life; for its pursuit, necessitating the constant inhalation of glass dust, shortened his days. The labours of such a man entitle him to the lasting esteem and gratitude of all lovers of the Microscope, as well as of that field of investigation to which this instrument is the indispensable portal.'"

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Mr. B. W. Thomas's slides of sand obtained by washing clay from the boulder-drift of Meeker county, Minn., U.S.A., were explained by Mr. Crisp. In similar specimens, Professor Leidy had recognized some well-preserved and characteristic Foraminifera, of which two forms appeared identical with *Textularia globulosa* and *Rotalia globulosa*, now living in the Atlantic Ocean. The fossils Mr. Thomas supposes to be derived from a soft yellow rock, cretaceous shale and lignite forming part of the drift. He also reports the finding of fragments of marine diatoms in the clay.

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**The following Instruments, Objects, &c., were exhibited:—**

Dr. C. H. Golding-Bird:—Microtome.

Mr. H. Boecker:—Slides of Bacteria, Bacilli, &c.

Mr. Chadwick:—*Halecium halecinum*, mounted as described *ante*, p. 151.

Mr. Cheshire:—Curious form of *Spirillum*.

Mr. Crisp:—
(1) Old Microscope.
(2) Reichert's Microscope, with modified Abbe Condenser.
(3) Reichert's Polarization Microscope.
(4) Griffith's Multiple Eye-piece.
(5) Glass Frog-plate.
(6) Getschmann's Slides of arranged Diatoms, &c.
(7) Bradley's "Mailing Boxes."

Miss Dancer:—Objects found in flue-dust and coal-ash.

Mr. Guimaraens:—The slide of *Xanthidium* exhibited at the last meeting.

Mr. A. W. Stokes:—Fish-trough.

Mr. B. W. Thomas:—The slides mentioned *supra*.

Dr. G. C. Wallich:—A Rotalian from closed flint nodular cavity metamorphosed into chalcedony.

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**New Fellows:**—The following were elected *Ordinary* Fellows:—Messrs. Henry W. Fuller, H. A. Johnson, M.D., James C. Stodder, H. Thomas, M.D., and G. F. Turton.